LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

DTIC ACCESSION NUMBER

LEVEL

0

INVENTORY

Bird Strike Committee Europe (BSCE), 14th meeting

DOCUMENT IDENTIFICATION

1979

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR

NTIS GRA&I
DTIC TRAC
UNANNOUNCED
JUSTIFICATION

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DATE ACCESSIONED

DATE RETURNED

19990910 079

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

H A N D L E W I T H C A R E

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	1979	Conference Proceeding 22-26 Oct 79

4. TITLE AND SUBTITLE
Bird Strike Committee Europe (BSCE) , 14th Meeting, The Hague, Netherlands, 22nd to 26th October 1979

5. FUNDING NUMBERS

6. AUTHOR(S)
Bird Strike Committee Europe

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Bird Strike Committee Europe

Statens Luftfartsvaesen, Luftfartsdirekoratet
Civil Aviation Authority, Directorate of Civil Aviation
Gammel Kongevej 60
DK-1850 Copenhagen, Denmark

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Bird Strike Committee Europe

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copyright waived per email from Willemijn Prast, Sent: Wednesday, September 01, 1999, To: Short, Jeffrey, USAF IBSC Representative, Tyndall AFB, FL 32403.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

A

13. ABSTRACT (Maximum 200 words)
The Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendence is open to participants from other parts of the world. Annual Meeting Proceedings include Chairman's Report, Working Group Reports and Papers Presented:

The first ten years of BSCE. V.E. Ferry, France.
A forecast system for bird migration in Sweden. Bertil Larsson and Thomas Alerstam, Sweden
Code of practice of Bird Strike Committee Europe. L.O. turesson, Sweden
American initiative in bircontrol on a national scale. M.J. Harrison, USA
Geographical influence on flights of migratory birds in South East of France. M. Laty, France
A new method of studying bird migration. S.A. Gauthreaux, USA
Predictability of spring migration of snow geese across Southern Manitoba, Canada. H. Blokpoel, Canada
Effect of light beams on birds. F.J. Verheyen, Netherlands
Bird Strikes 1977 Civil a/c. J. Thorpe, UK
Bird Strikes 1977 Mil a/c. P. Kingston, UK
New procedures for evaluation of radarinformation. J. Becker, Germany
New procedures for publication of bird warnings and forecasts. J. Hild, Germany
Regulations for the bird strike representatives of the civil airports in the Federal Republic of Germany. W. Keil, Germany
Experiences about the bird strike regulations of the Federal Ministry of Transport since 1974. W. Keil, Germany
Laser and symbolic lights on birds in order to prevent bird aircraft collisions. K. Mossler, Sweden
A probalistic model of evaluating birdstrikes threat to aircraft crew enclosures. B.S. West, R.E. Wittman, USA.
The quality of identification: a microscopic key to determination of feather remains. T.G. Brom, L.S. Buurma, Netherlands.
The quality of identification: its effects on birdstrike statistics. T.G. Brom, L.S. Buurma, Netherlands.
Pattern of bird migration over the Netherlands: a classification illustrated with radarfilm. L.S. Buurma,, Netherlands.
Certification aux ingestions du moteur SNECMA/GE CFM 56. France
Solution propre a las France: sensibilisation des personnels. M. Briot, France
Tests of a device for the protection of aircraft gas turbine engines against bird strikes. M.S. Wooding, UK
Is it necessary to destroy birds on aerodromes? V.E. Jacobi, USSR
Information to pilots about the danger of bird strikes. C. Bakker, Netherlands
ICAO activities related to bird strikes. C. Bakker, Netherlands
Bird Risk and Air Safety. G. Marcal, France
Bird strikes to Aeroflot registered aircraft and some general airworthiness requirements. Dr. Trunov, Mr. Rogatchev, USSR
About the procedures aimed at bird strike avoidance. V.E. Ferry, France
Summary of results of spraying with "RETA" repellant at Ben Gurion Airport 1974-1979. S. Su-Aretz, J. Agat, Israel.
Bird control at Helsinki-Vantaa Airport, Finland. S. Kuusela, O. Stenman, Finland

14. SUBJECT TERMS
Bird Strikes, Aviation Safety, Airports, Hazards, Survivability, BSCE, International Bird Strike Committee, IBSC

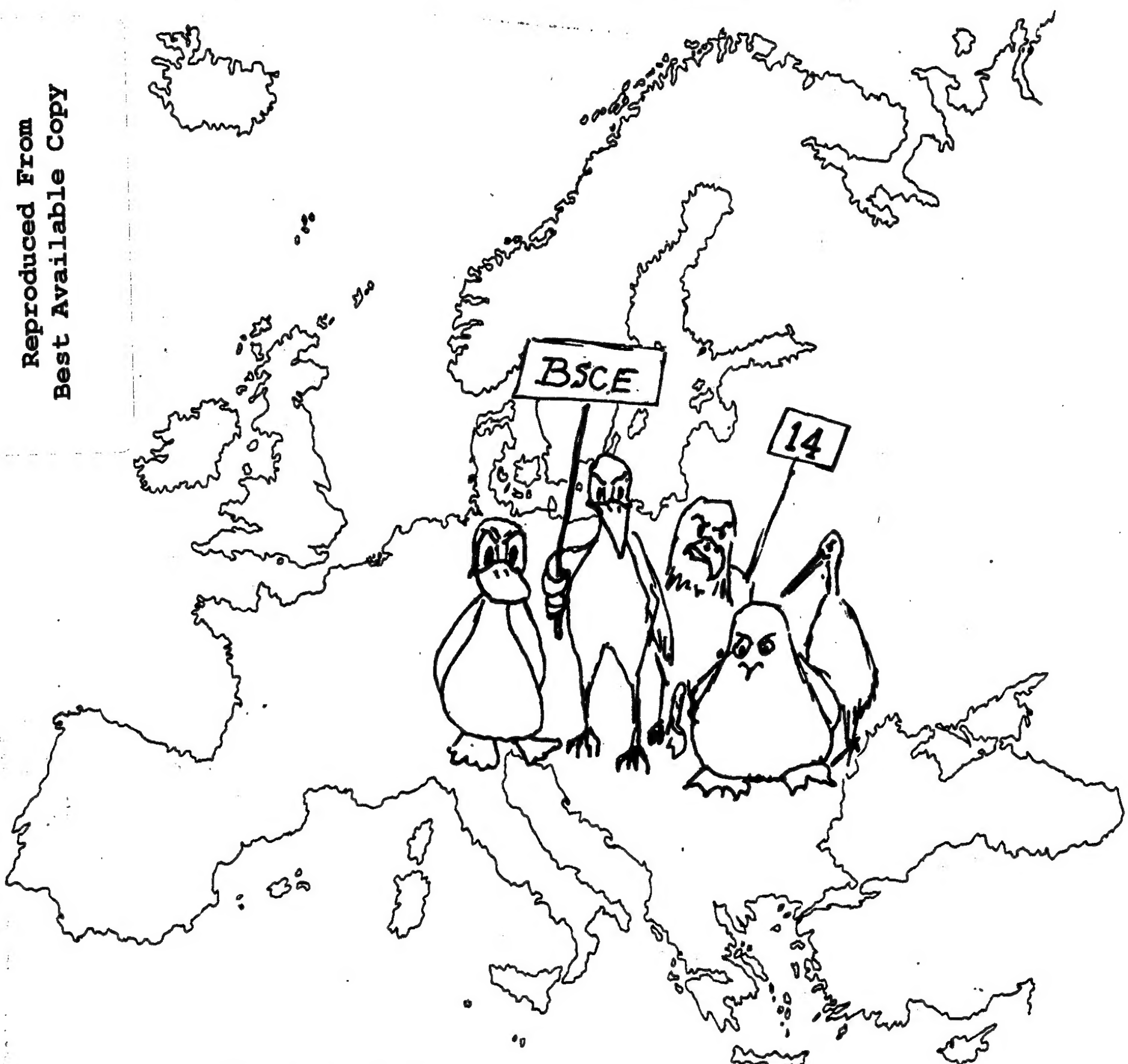
15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19, SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

14th MEETING

BIRD STRIKE COMMITTEE EUROPE



BSCE-THE HAGUE-22nd to 26th October 1979

Table of contents

STATENS LUFTFARTSVÆSEN
Luftfartsdirektoratet
CIVIL AVIATION AUTHORITY
Directorate of Civil Aviation

Dato
Date 30 September, 1980

Deres ref.:
Your ref.:

Vor ref.: 13-70102 -/UJ
Our ref.: 11th December, 1979

Captain Jeffrey J. Short
USAF Bird/Aircraft Strike Hazard
AFESC/DEVN, Tyndall AFB
Florida 32403
USA

Eft.:
Info.:

Dear Sir,

BSCE Booklet on Measures for Reduction of Bird Strike Risks around Airports

Made aware of an unfortunate error, which had crept into the BSCE Booklet on page 34, I hasten to send you enclosed the revised paragraph (d) supplied by the United Kingdom.

Yours sincerely,

H. Dahl

Kellerman

Enc. p. 34 of the BSCE Booklet

Postadresse/*Mail Address*
Gammel Kongevej 60
DK-1850 København V
Denmark

Telefon (01) 31 48 48
Phone +45 1 31 48 48
Telex 27096

Postgiro/*Giro Account*
600 1629

Bankkonto/*Bank Account:* 8041-5
Danmarks Nationalbank
DK-1093 København K
Denmark

The Netherlands

Chemicals to make the airport surroundings unattractive to birds are not used. So far no chemical method has proved to be successful. Concerning the military airports no special anti-bird chemical has ever been used. Only chemicals against seed-bearing and bird attrating weeds have sometimes been applied.

South Africa

At one airport an insecticide was used to kill insects on which the birds feed, but the results were disappointing.

United Kingdom

Birds are not attracted by soil per se, only by the seed or insect life it supports. Chemical methods to reduce the food supply are used as local needs dictate given identification of local requirement:

a) As a fertilizer to improve growth of "long" grass which deters some birds species. An annual dressing after the first cut of the season has been 25 to 37.5 kg/ha each of P and K, with addition of N where necessary.

b) As selective weedkillers used to reduce number of broad-leaved plants to reduce seed and foliage available for herbivorous birds. These are based on a UK booklet "Approved products for farmers and growers" which is revised annually.

c) As Lumbricide and insecticide application to control earthworms and insects but in recent years the only use has been of DDT to control tipulids (cranefly larvae, etc.) by BAA at Heathrow over the past 2 years. They use DDT concentration approx. 1.5 litres of 25 % emulsifier to 100-130 litres water. Results have been encouraging in that the relevant bird population has been reduced significantly during the "cranefly" season. Other airports are considering the technique but have been advised.

   a) to ensure the insect correctly identified to the bird problem, and
   b) that approval is obtained before use from local agricultural and Water Authorities.

d) To date in UK, chemical methods of repelling birds directly have not been successful. An attempt recently to repel Lap Wings by an application on grass of synergised aluminium ammonium sulphate (RETA, CURB) proved unsuccessful. The results will shortly be published.

USA

Chemicals are not, to our knowledge, used on airport soils to make the airport unattractive to birds. Chemicals such as Avitrol have been used on garbage dumps

SECTION 1.

OPENING SPEECH.

By Mrs. Drs. N. Smit-Kroes
State Secretary for Transport
and Public Works.

Mister Chairman, ladies and gentlemen,

On behalf of the Netherlands Government I welcome you and I am pleased that this year The Netherlands was chosen to be the host country for the meeting of the Bird Strike Committee Europe.

We are all aware that bird strikes have been a problem since mankind started flight.

However during the past decade the menace caused by the birds has increased considerably.

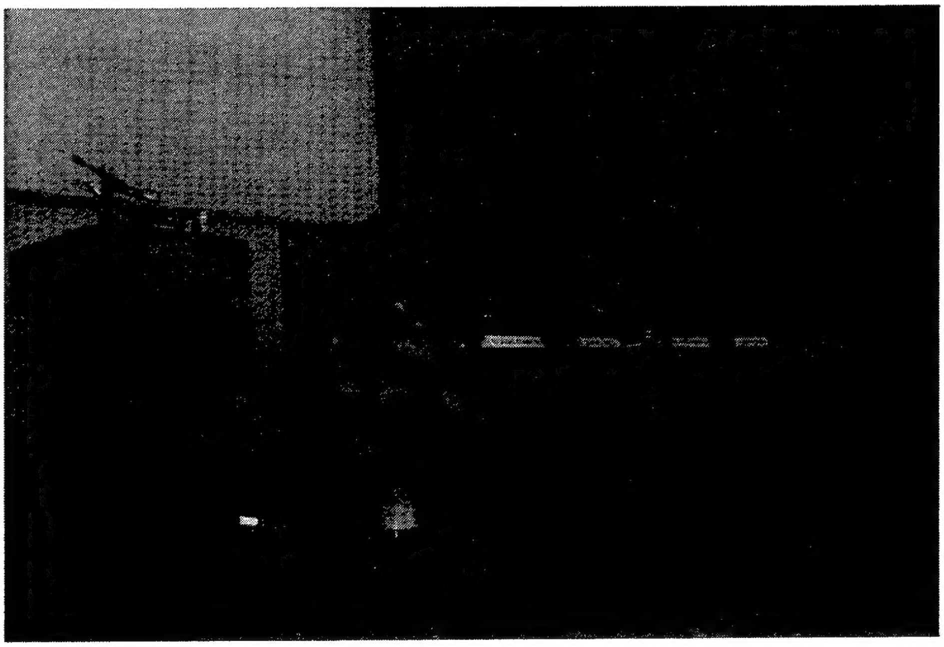
This increase of bird strikes can be related to one or more of the following factors:

- increasing aircraft speeds
- an increase of aircraft movements
- the development of wide-bodies with the inherent greater risk of loss of life
- the development of an expensive, highly sofisticated technology, which raises the repair costs of damage, resulting from bird impact.

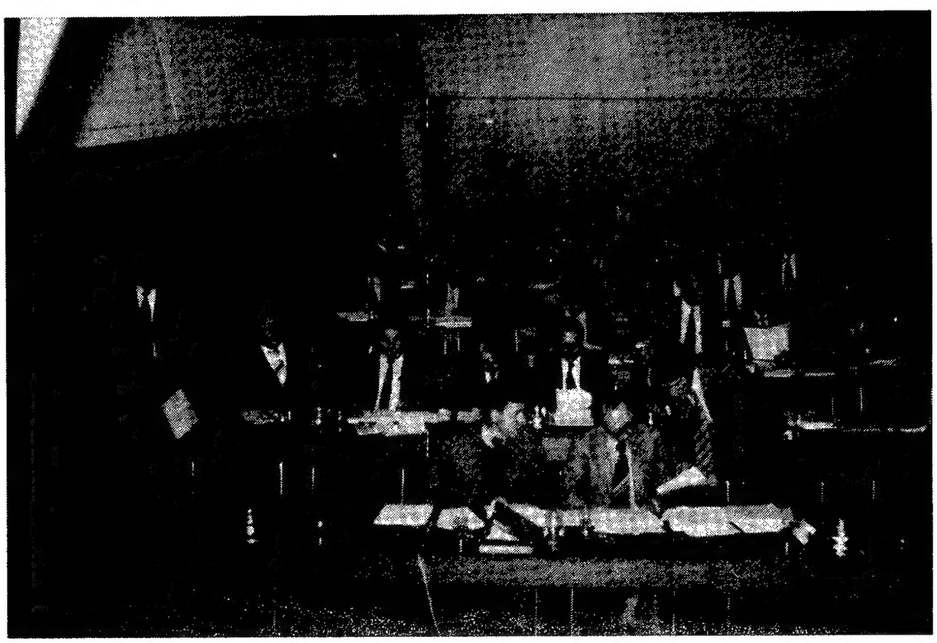
Experience gained during the last decade indicated that the bird problem will not entirely be solved in the foreseable future and therefore we must accept that your efforts in minimising bird hazards to aircraft will remain a long term project. Long term problems needs long term friends and I am glad to say that one of the merits of the Bird Strike Committee Europe is, that we are able to widen our view and have found ways of using the knowledge gained so far, in such a way that we now have achieved a considerable reduction in bird strikes in The Netherlands.

I know that it is not realistic to draw conclusions from statistics, which only cover a few years. They nevertheless show

us a decrease in bird strikes, which might be considered as an indication of following the right course in preventing bird collisions.
But regardless of the solutions which are found to counter the bird problem, we are beginning to realise that we have to learn to live with birds.
Public opinion in Europe is tending to a more protective attitude in relation to the environmental conditions.
Moreover we become aware that we have been handling nature in a way which resulted in circumstances which we had not foreseen.
In other words: we destroyed to many components of our natural surroundings and we ought to realise that we have to be careful with what is still left. Therefore I think it is a considerable task for the Bird Strike Committee Europe to create solutions of a rather more bird-evasive than a destructive kind.
I sincerely hope, that some real progress will be achieved in this field and I am confident you will succeed.
On the other hand, your presence in The Netherlands should give you the opportunity to get to know it better and therefore I hope that you will see more of this country than only the surroundings of the congress centre and your hotel.
I herewith open this plenary session and wish the chairman and participants of this congress a succesful meeting and a nice stay in The Netherlands.



Words of welcome from the chairman of B.S.C.E. Mr. L.O. Turesson to Mrs. Drs. N. Smit-Kroes, State Secretary for Transport and Public Works.



Plenary meeting in the Sweelinckhall.

Miss K. Mossler
Sweden.

Mr. H.J.D. van Wessum
Dept. of Civil Aviation
The Netherlands.

Oberst E.P. Schneider
Acting Chairman
Denmark.

SECTION 2.

REPORT BY THE CHAIRMAN.

Report by the chairman 1979

Bird Strike Committee Europe is back to the Netherlands, one of the first host states for meetings of this organization and also the home country for its first chairman. Colonel Twijsel belonged to the small group of founders of BSCE, 13 years ago - a handful of them are here to-day - and he contributed in an excellent way to the starting up in Europe of this sector of flight safety work. Since then our activities have developped considerably but a good deal of the honour for the initiative and the good start belongs to the Netherlands. - Now to the events of the last year:

The thirteenth meeting of BSCE was held in Berne at the end of May - beginning of June 1978. It was a nice time of the year in an old and beautiful city; the Swiss hospitality was excellent and so were all the arrangements, from the first planning to the issue of the report with the golden eagle on the frontcover. We want to convey our sincere thanks to the organizing committee and to the authorities responsible for the conference.

Well, a big report of course describes all activities during a meeting and also contains recommendations for future work. Both things are of high importance but I will here concentrate in the latter. - All the working groups of BSCE have been active during the 16 months that have passed since the Berne meeting in a willing to comply with given recommendations and with new ideas about the work which are in many cases presented at this meeting. I would like to mention a few examples:

Aerodrome working group has finished its compilation of measures used to reduce bird strikes at airports. It's a fundamental document which can be used all over the world together with the well-known ICAO manual "Bird Control and Reduction".

The analysis of bird strike reports has taken a big step forward when BSCE in this sector of its work has entered the field of automatic data processing, latterly in close co-operation with ICAO.

New methods for distribution of bird warnings and forecasts will be presented at this session and in the two working groups Bird movement and Radar a raw of lectures has been given about migration studies by the aid of radar and about trials with forecasting systems which have by now reached a stage of almost operational.

Communications and Flight procedures working group is going on with a charge to prepare a booklet on procedures now in use and a delegate from the host state will here present a nice way of giving correct information on the bird strike problem to pilots.

Important tasks just now for the Radar working group are to examine the use of other remote sensing means than radars for bird observations (sodar, image intensification equipment etc). One working paper deals with this matter and an inquiry has been accomplished.

One of the main themes of BSCE 14 lies within the sphere of interest of the Structural testing of airframes working group and that theme has been given a special weight as our work in this field has started up only a few years ago. Three papers to be presented to-day will highlight the structure problems caused by birdstrikes.

About future meetings I can informe you that the Belgian "Administration de l'Aëronautique" has got the authorization to organize the 15th meeting of BSCE in the spring of 1981. - Several contacts have been taken with the organizers of an international ornithological congress in Moscow 1982 for the aim to have a symposium on a matter including our problems together with that congress. BSCE 16 is also planned to be held in connection with the big event in Moscow. Our liaison officer has taken up this subject and contributed to the progressing of it.

Finally a few words about our relations with other international bodies.

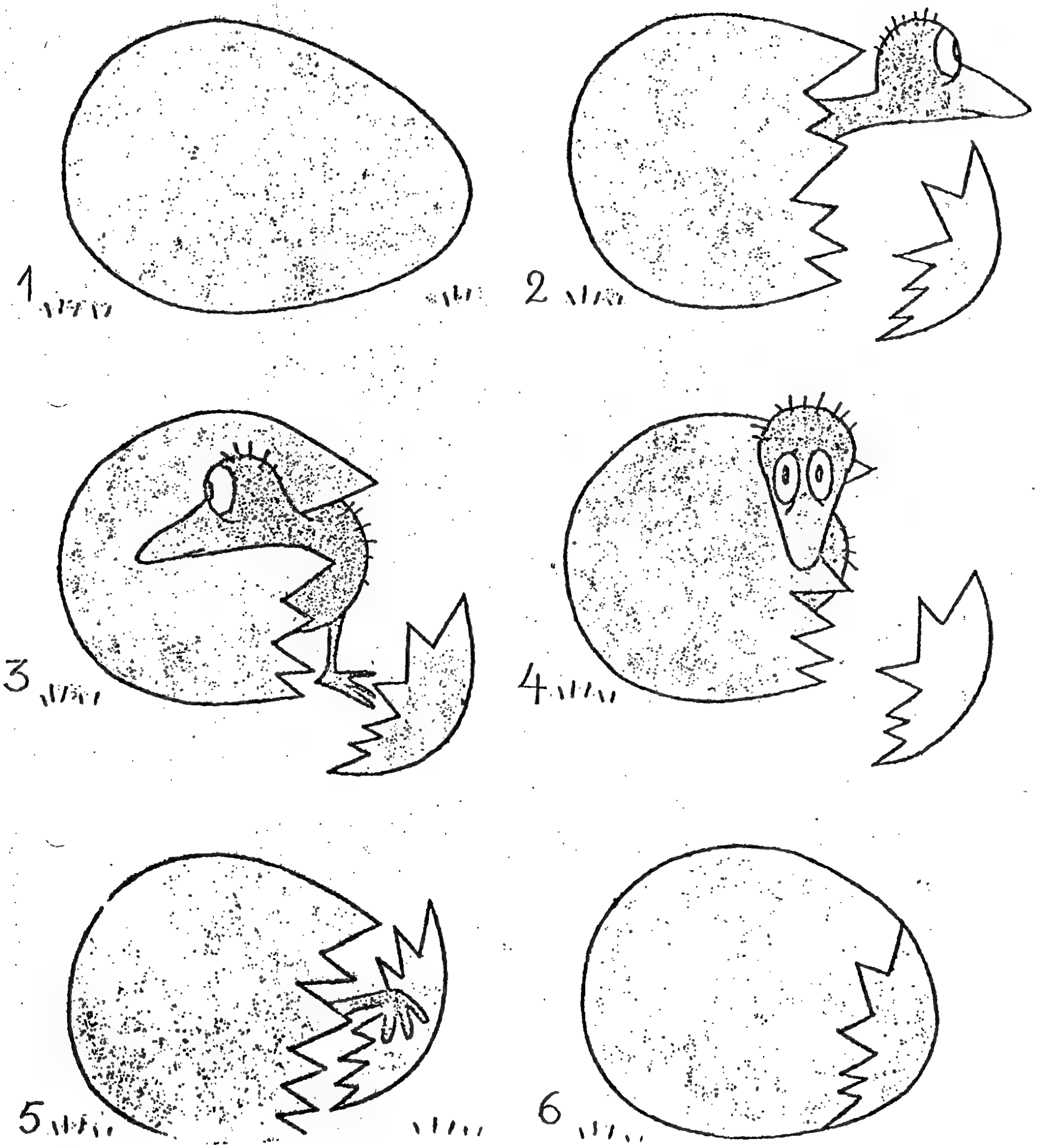
As I underlined before, BSCE is working in close co-operation with ICAO. This is valid not only for the computer programme for analysis of strikes but also for other sectors of our work. One important duty is to help our big brother with the carrying through of the serie of workshops on bird hazards to aircraft which started up in Bangkok 1978 and which is now planned to continue in different parts of the world during three consecutive years 1980, 1981 and 1982. BSCE has also contributed to the content of the document "Bird Control and Reduction" and we are grateful to ICAO for the initiative to realize such a work.

A matter of high importance for us was finished at the end of 1978 when the EEC Council directive on bird conservation was adopted. However, a follow up will here be necessary and the EEC member states will have to prepare annual reports including for instance scarring and killing of birds at airports (the latter is rare).

Co-operation with other international organizations like ECAC, IATA, IFALPA and IFATCA is also progressing. It might here be mentioned that IATA is helping us with the distribution of bird strike reports and that an address from BSCE was presented at the last annual meeting of IFATCA. - We really need help from and co-operation with the main international bodies in the field of aviation.

This was shortly about some matters that we are engaged on. I have good reasons to expect a successful meeting when looking at the list of interesting papers and as I know how careful the preparational work of the organizing committee has been. Thank you very much for a good planning and arrangement of this conference.

Lars-Olof Turesson


1
2
3
4
5
6

REPORTS BY CHAIRMEN OF WORKING GROUPS

CHAIRMAN'S REPORT

1. Title: Analysis

2. Terms of Reference - Collection, analysis and circulation of statistical information relating to bird strikes.

3. Recommendations from 13th meeting, Berne May 1978.

A. Each airline should be encouraged to make bird strike reporting forms available in the cockpit of every aircraft.

B. In accordance with ICAO State Letter AN3/32-76/111 "Foreign" bird strikes should be made known to the country in which they occur. In the Far East Asia/Pacific Region these should be sent via the ICAO Regional Office in Bangkok, who have agreed to act as coördinators.

C. Previous recommendations on the necessity of obtaining Cost figures, and on circulation of information on Serious Incidents, are again tabled.

D. That the ICAO definition of a bird strike is not complete, and should be amended to include "2.5(c) observation of a collision between a bird and an aircraft by pilots, ATC, aerodrome personnel, etc."

E. Recommendation 2b from the 11th meeting dealt with the proper identification of bird remains. In order to find out if this has been done the WG Chairman would make an enquiry from BSCE members.

4. Work Programme.

A. Prepare a multi-language table of bird names and their mean weights.

B. Modify the format and content of statistics of military and civil aircraft according to the decision taken by the group at the 13th BSCE-meeting.

C. Circulate a firm proposal on joint participation in a computer data base for bird strikes recorded in Europe, and to develop codes.

5. Progress Since Last Meeting.

5.1. Owing to a change of post Mr. J.G. van Dusseldorp has been unable to continue as Vice Chairman, however he has been ably replaced

by Mr. H.J.D. van Wessum, also from The Netherlands Department of Transport.

5.2. Before his resignation the Vice Chairman produced and distributed the first edition of a multi-language table of bird names. The bird names were Scientific, English, Dutch, French, German, together wit mean weight.

5.3. The following countries have supplied their analysis in BSCE form since the 13th meeting in Berne.

	Civil		Military	
	1977	1978	1977	1978
Austria	V	V		
Belgium	V	V	(V)	
Denmark	V	V		V
Eire	V			
France	V			
Germany	V	V	(V)	
Netherlands	V	V	V	
Norway	(V)	V	V	
Portugal	V	V	V	
Sweden	V	V	V	
Switzerland	V			
UK	V		V	
USAFE			V	

Other countries will be sending their information shortly.
(V) Unable to be included in paper.

5.4. From the above analysis "Bird Strikes During 1977 to European Registered Civil Aircraft", has been produced by the Chairman and Vice-Chairman, and the UK RAF representative has produced "Military Aircraft Bird Strike Analysis 1977".

5.5. The Chairman attended a meeting at the ICAO headquarters in Montreal to discuss the formation of an ICAO bird strikes data base, and the revised reporting form. ICAO are establishing a system which is similar in many respects to the proposals which

the working group has agreed to as an European system (is similar to the Australian system). The working group has been informed about the ICAO proposals, including the Computer layout.

5.6. Issue 4 of the Bulletin of Serious Bird Strike Incidents to Civil Aircraft was sent out on 12 March 1979.

5.7. The Chairman has produced a document, AWG 1 which details all Fatal and Serious bird strike incidents to transport sizes civil aircraft. A similar document AWG 2 covers Light Aircraft and AWG 3 will cover Helicopters. These have been given to appropriate Members of the Analysis Working Group, and will be included in the Report of the 14th BSCE-meeting.

5.8. The working group assisted in providing comments for ICAO on the proposed new reporting form.

5.9. The working group has rejected the recommendation passed to it by the Aerodrome Working Group that the hazard level of all bird strike incidents should be categorised from A. to E. This was considered to be too big a task and the division between damaging and non-damaging strikes was sufficient.

5.10. For analysis purposes it was agreed that bird strikes occurring below 500 ft at an aerodrome would be included in the total for that aerodrome, whilst between 500 and 2500 ft they would be considered as being near that aerodrome.

5.11. The Military Analysis now consists of only the following Bird Species, Part Struck and Damage.

5.12. The Civil Analysis now consist only of Aircraft Type, Aerodrome, Bird Species, Part Struck, Effect, Airline and Cost of Strikes.

5.13. The 1978 Analysis will be completed during early 1980 and circulated to the working group. The 1979 Analysis (together with 1978) will be presented at the 15th meeting in 1981. The 1980 Analysis should be via the ICAO computer system.

Proposed

6. Recommendations.

6.1. That the ICAO work on the establishment of an International Bird Strike Data Base be endorsed.

6.2. That the usefulness of even very small parts of feathers in identifying bird species be emphasised to pilots, maintenance personnel etc., particularly when damage occurs. Photographs were thought to be an important way of doing this. International coöperation is necessary where engines are repaired in another country.

6.3. That bird strikes to aircraft from another country be sent annually to the appropriate person in the country of register by 31st January, in order that these may be included in that country's national analysis. An address list of relevant persons is attached.

6.4. That ICAO be requested to amend the definition of a bird strike to include "2.5(c) observation of a collision between an bird and an aircraft by pilots, ATC, aerodrome personnel, etc.

LIST OF ADDRESSES

The addesses below give the appropriate person who should be sent a copy of bird strikes reported

- in your country to aircraft from another country
- to aircraft on your National Register which are struck in another country

AUSTRIA

Mr O Lhotsky
Ministry of Transport
Department of Civil Aviation
Elisabethstrasse 9
A-1010 Vienna
AUSTRIA

BELGIUM

Mr M Haerynck
Ministry of Communications
Administration de l'Aeronautique
WTC Tower I 8th Floor BUS 60
Blvd E Jacquemain 162
1000 Brussels
BELGIUM

DENMARK

Mr N H Dahl
Luftfartsdirektorater
Codenhus G L Kongevej 60
1850 Copenhagen V
DENMARK

FRANCE

Mr J L Briot
Service Technique de la
Navigation Aerienne
246 Rue Lecourbe
75015 Paris
FRANCE

FINLAND

Mr O Uusitalo
National Board of Aviation
Box 50
SF 01531 Helsinki-Vantaa-Lento
FINLAND

GERMANY

Mr W Politt
Luftfahrt Statistik
Luftfahrt Bundesamt
Postfach 3740
2200 Braunschweig Flughafen
WESTERN GERMANY

REPUBLIC OF IRELAND

Mr S Jackson
Air Navigation Services Office
Dept of Tourism & Transport
Kildare Street
Dublin 2
EIRE

ITALY

Mr V Lucci
Capo Servizio Coordinamento
Aeropoto di Fiumicino
Rome
ITALY

NETHERLANDS

Mr H J D van Wessum
Dept of Civil Aviation
Plesmanweg 1-6
2597 JG The Hague
NETHERLANDS

NORWAY

Mr J Michaelsen
Zoological Museum
Sarsgate 1
N-Oslo 5
NORWAY

PORTUGAL

Mr J P Santos
Direccão de Navegaçáo Area
Arruámento B - Edificio 6
Aeroporto Lisboa
Lisbon
PORTUGAL

SWEDEN

Mr L-O Turesson
Board of Civil Aviation
Fack
S601 01 Norrköping
SWEDEN

SWITZERLAND

Dr B Bruderer
Schweig Vogelwarte
Sempach
CH 6204
SWITZERLAND

TURKEY

Mr U Bakanliği
Sivil Havacilik Gn
Md Lügü istasyon
Ankara
TURKEY

UNITED KINGDOM

Mr J Thorpe
Safety Data Unit
Civil Aviation Authority
Brabazon House
Redhill
Surrey
RH1 1SQ
UK

UNITED STATES OF AMERICA

Mr M J Harrison
Federal Aviation Administration
Office of Airport Standards AAS-300
800 Independence Ave SW
Washington DC 20591
U S A

USSR

Dr O Trunov
Ministry of Civil Aviation
37 Leningradsky Prospekt
Moscow 125167
USSR

ACTIVITIES OF THE WORKING GROUP

1. Title: Communication and flight procedures

2. Recommendations from the 13th meeting.

   1. That, in support of recommendation made during 12th meeting the group should be reactivated.

   2. That an experimental use of ATIS for transmission of bird movements information be started in countries and a summary of the experience gained in so doing be prepared by the group.

3. Progress report.

   1. All the tasks assigned to the group by the Committee during the 11th meeting (London - May 1976) and confirmed during the 12th are considered as a permanent basis for any further activity of the group.
   2. A movie made by US Air Force for airport personnel training on bird hazards was presented.
   3. Working paper 27 and 31 were analysed and their contents are reflected in the following items.
   4. Since it is recognized that birds are a potential danger to aircraft on or near runways the working group emphasises the fact that there is, on this aspect, responsibility for action on the part of all three parties envolved in this , namely:

      A. the pilot
      B. the Air Traffic Controller
      C. the Airport Authority
   5. For bird control at airports one of the recognized methods for avoidance of bird strikes is restriction for runways in use e.g.
      A. inspection before use
      B. preferential use of no more runways as strictly needed at the same time.
   6. Evaluation will be taken up of the proposal for warning pilots about presence of birds, including consultation of the proper authorities like Air Traffic Control Authorities and Pilot Organizations.

Draft recommendations.

1. That an experimental investigation be conducted in Europe in order to evaluate the possibilities and implications of special procedures developed to avoid bird strikes.

2. That ample and proper warning be given about operational restrictions on the use of runways imposed by the danger created by bird activities.

Chairman's REPORT

Activities of the Working Group

1. Aerodrome.
2. Recommendations from the 13th Meeting.
   The group will prepare a brochure in which all the procedures to reduce bird hazards on aerodromes will be listed and explained.
3. Work to be done inside the Aerodrome Working Group.
   i) ensure that all information collected by the group about homing pigeons in the vicinity of airports is reflecting the situation as regards breeding or racing pigeons.
   ii) collect the results of experiments carried out in various countries about the application of chemical agents as bird repellents and evaluate their operational use.
   iii) collect information on the economical and operational aspects of the bird strike prevention measures.
   iv) prepare a booklet describing the measures available to the airport management for the reduction of bird hazards at airports.

4. The chairman not being present the vicechairman of the group informed the meeting that the requested booklet had been sent out and that the information concerning the homing pigeons problem had been clarified by correspondence and together with late incoming information from different administrations and various countries taken into account when preparing the booklet.
   As the questionnaire on the economical and operational aspects of the bird prevention measures has not been issued before the latter part of september this year it was agreed to discuss this item at the next meeting.

The vicechairman recognized the difficulties in giving accurate figures to the questonnaire, but urged the members of the group to give the best estimates available and regarding countries with a number of airports to give figures from the major airports and some figures from selected smaller airports.

As some information on application of chemical agents as bird repellent could be found in the booklet of july 18th, 1979 the vicechairman intended to send a questionnaire in a years' time asking information on the results of recent experiments in this field to be able to present a working paper on this item

- at -

at the meeting in spring 1981.

5. The papers 15 and 16 regarding regulations for the bird strikes representatives of the civil airports in the federal republic of Germany and experiences about the bird strike regulations of the federal ministry of transport in Germany since 1974 were presented.

A paper on the use of the RETA repellent in Isreal was presented.

After presentation of working paper 17 laser and symbolic lights on birds in order to prevent a bird aircraft collisions the vicechairman undertook to collect information on experiments in this field to be presented at the next meeting. It is the intention to send out a questionnaire in a years' time to cover the most recent development in this field for presentation at the next meeting.

6. After presentation of slides of one biologist to countries outside his own country at the specific request of one airline a long discussion followed on the timeliness of such an approach to the problem of dealing with bird strikes in countries where the responsible authorities were reluctant to take such measures.

The consensus of the meeting was that should such request be made in the future the utmost effort should be made to secure international co-operation and the biologist approache should contact the civil administration of his country with the aim that this administration get in touch with the relevant ICAO regional office. In this connection the good results that was achieved by the workgroup-meeting in Bangkok 1978 was mentioned.

Thepapers 2 3 and 2 9 were presented.
The vicechairman agreed to send out a questionnaire to collect information on the code of procedure in the different countries to how to make sure that the equipment to scare away the birds from the airport is properly used and maintained as other procedures regarding ecolocical survey on the surroundings and regarding patrolling of the airport area to scare away birds are observed.

Concerning WP 29 the meeting was of the opinion that the first proposal on the urgent necessity of setting up a system of taking immediate action at airportss was too vague to be adopted as a workinggroup recommandation.

- Recommandation -

Recommandation No 2 on the adoption of a classification of the types of incidents according to their extent and degree of seriousness was referred to the analysis group.

Due to legal implications the meeting could not agree to the third recommandation on the adoption of a classification of an airport according to their degree of progressive or undisputed bird risk.

BSCE Aerodrome Working Group Meeting 22/10-79 1330

Name	Organization/country
H. Dahl	Denmark
A.M. Glennung	Denmark
Arie Klaver	Schiphol Airport Holland
L.G. Delanghe	Belgium
Lucci V.A.	Italia
H.P. Bouhuijs	Rotterdam
O. Uusitalo	Nat. Board of Aviation/ Finland
O. Stenman	Finnish Game and Fish, Resh. Insp.
J. Michaelsen	Zoological Museum, Oslo/ Norway
M. Lüthi	Swiss Air Force
I. Tengeler	LEOK/TNO NL
N. Swink	Fish & Wildlife Service/ U.S.A.
J. Delol	France
John L. Seubert	Fish & Wildlife Service/ U.S.A.
Tim G. Brom	The Netherlands
S. Zerkovitz	Hungary
E. Tunali	Turkey
Ziya Aktürk	Turkey
Shalom Suaretz	Nature Reserves Authority, Israel
J.H. Lauritsen	Royal Danish Air Force
B. Bruderer	Schweiz. Vogelwarte/ Switzerland
B. Junker-Hansen	Game Biology Station, 84/0 Ronde, Denmark
Kjell Nilsson	IATA Geneva
G.J. Plukkel	IFALPA
F. Kuyk	RLD/Netherlands
J. Short	AFESC/DEVN TAFB, FL 32403 U.S.A.
Sidney A. Gauthreaux, Jr.	Clemson University-S.C. U.S.A.

Name	Organization/country
Schneider E.P.	Denmark
Haerynck M.	C.A.A. Belgium
J.F. Boomans	Belgian Air Force
V.E. Ferry	French Civilian Aviation
A.H. van Geuns	Netherlands (Schiphol)
José Pimentel Santos	Portugal
D. Bruessow	Germany
Dr. Hild	Mont Royal, 558 Traben-Trarbach
T. Brough	Aviation Bird Unit, Ministry of Agricultural, England
K. Wilde	ICAO
L.O. Turesson	Swedish Board of Civil Aviation
R. Kingston	Ministry of Defence (Inspector of Flight Safety)
Bertil Larsson	Krigsflygskolan /, RSAF Sweden
Dr. Keil Werner	D - 6000 Frankfurt/M
Karin Mossler	The Royal Institute of Technology, Sweden
Johnny Karlsson	Sweden, University of Lund
Trunov, Dr.	USSR, Civ. Aviation Research
Kanin. Dr.	USSR, Moscow State University
Ugarkin	USSR, Civ. Av. Ministry
Dwornikow	USSR, Air Force expert for flight safety
P.H.C. Lina	The Netherlands
E. Dallo	France Aviation Civile

BSCE 14/79

Activities of the working group.

1. Title: Bird movement working group.

2. Terms of reference: Study of bird concentrations and movements and drawing up of special bird hazard maps for informal and planning purposes.

3. Progress report:

a) An European bird strike risk map showing areas with high and medium risk - based on density of birds - as well as periods with high/medium risk was drawn up and is printed.

b) That coloured map - scale 1:2.000.000 - will be published in spring 1980. Countries are requested to inform GAF about their wishes (no. of maps).

4. Future program:

a) Further revision of now existing map.

b) Collection of bird concentration and migration data.

5. Recommendations:

a) The new map should be used as an informal map for civil aviation and as a planning map for military aviation.

b) The new map should be used together with birdtam and forecasts as an advisory background.

c) Further data about bird concentrations and bird migration be collected by each country and sent to the chairman in order to enable a new edition of the now existing map.

Dr. Hild, Germany

BSCE 14th, 26 October 1979

CHAIRMAN's REPORT.

Activities of Radar Working Group

1. Title: Radar

2. Terms of Reference - Matters associated with use of radar in the surveillance, the identification and the assessment of bird presence and movements.

3. Recommendations from 13th Meeting, Bern May 1978.

   The committee confirms recommendation C1/BSCE 12 and emphasizes the need to improve the active collaboration in bird migration research in Europe.
   The Committee also recommends that in addition to the radar chain along the Alps, a second chain should be established throughout the North Sea area, if technically possible.

4. Programme between the 13th and the 14th Meeting.

   a) Take action towards the organization of the two radar chains recommended by BSCE.
   b) Investigate the use of SODAR (Sound Detecting and Ranging) or acoustical sounding equipment in bird detection in the atmosphere and prepare a short report.
   c) Examine the use of image-intensification equipment for bird detection at night near and on airfields and prepare a detailed report.
   d) Examine the use of infrared viewing equipment for bird detection at night.
   e) Prepare a questionnaire on standardization in obtaining height information.

5. Progress since last meeting.

   a) In November 1978 the chairman sent letters and guide-lines on the recording of bird migration to the authorities of Austria, France, Germany, Italy and Switzerland. Positive answers were received from Switzerland (one radar at Zurich and one at Geneva), and from Germany (one radar at Munich). A negative answer was received from Austria. A second set of informations accompanied by a supporting letter of the Civil Aviation Authority of Switzerland was sent out in August 1979. However, it seems clear to the Working Group that personal contacts should back up the approaches in Austria, France and Italy.

During a meeting of BAF, GAF and RNLAF in Belgium concerning the improvement of BIRTAM exchange, the vice-chairman distributed the proposals on the North Sea Chain. Germany agreed to involve a civil station near Bremen. Belgium is willing to join the project if the present radarfacilities are still available.
At the meeting we got positive indications for future collaboration with Denmark and Norway.

b, c and d)

Three workingpapers had been prepared by the chairman on the possible use of SODAR-, IR- and Light amplification equipment for the observation of birds,according to the tasks allotted to the Group by BSCE 13.
Drafts of the papers were sent out in August 1979. Comments came in from France, The Netherlands and Sweden.

b) With respect to the use of SODAR it can be stated that theoretically birds can be detected with a SODAR and that there is some empirical evidence that bird echoes sometimes appear on SODAR-recordings. However, the limiting factors (low puls repetition frequency, low range, high sensitivity to turbulences in the air and to ambient noise) make clear that SODAR is not apt to become a good new instrument for bird observation (especially in the vicinity of an airport).

c) With respect to the use of image intensification equipment it was stated that the problem of the detection of birds in the air is covered by the paper to be delivered by S. Gauthreaux to the plenary meeting and that the Group will only deal with the detection of birds on the ground. The conclusions were:

Our estimations on the resolution of the available systems and the detectability of birds suggest that image intensifiers may be of some value for the observation of birds on airfields. Satisfying results may be attained by tele-lenses of 300 and 500 mm; this, however implies a limited field of view (2 to 4^{o}) and the use of a tripod.
Further experiments are worth to be carried out, even with smaller tele-lenses (in order to make easier the handling and to increase the field of view) and with the additional use of artificial lights (according to preliminary experiments in the Netherlands).

d) Wit respect to the use of infrared equipment it was concluded that at the present state of development IR equipment is more limited than the light amplification technique (resolution, heat insulation of feathers, temperature difference between object and surroundings in passive systems; resolution and propagation of relatively long waves in the case of active systems). Further developments should however be recognized, especially for scientific use.

A preliminary questionnaire on altitude information was distributed to member-countries. It revealed that:

- only special measurements with height finder radars and narrow beam search radars can provide usefull adhoc height information.
- usual observations and radars with a broad beam in the vertical plane are of very limited use with respect to altitude.
- actual adhoc height measurements are only made by Sweden and Belgium.
- by the time being general biological knowledge on altitude distributions may be used in the BIRTAM and in regulations; this is done by Germany and France while Denmark and The Netherlands don't give height information in each message but use certain fixed altitudes in their flight restrictions.

During the Working Group session three papers were presented:

WP 7: Geographical influence on flights of migratory birds in South East of France (M. Laty);

WP 13: New procedures for evaluation of radar information (J. Becker);

WP 21: Pattern of bird migration over The Netherlands: a classification illustrated with radar films (L.S. Buurma).

6. Future work.

a) A questionnaire has to be sent out in order to get information on the available experience and the feasibility of experiments with light amplification and IR equipment in the different countries.

b) Coördinated radar observations along the Alps and the North Sea have to be carried out as far as the collaboration of the different countries allowes.

7. Recommendations.

The recommendation of BSCE 13 is still valid,

B. Bruderer/L.S. Buurma

Activities of the Working Group.

1. Title: Structural Testing of Airframes.

2. Committee and Working Group Recommendations from Third Meeting of Group (BSCE 13, Berne, June 1978).

Committee

D-1 That, to facilitate a more positive and orderly response by BSCE participating countries to the tasks of the Working Group, a member should be appointed by the national committee for bird strikes of each participating country to be responsible for reporting to the BSCE progress in support of the recommended tasks of the Working Group.

D-2 That the attention of pilots and operators should be continued to be drawn to the deterioration in bird impact resistance of windscreens which rely on the maintenance of an optimum temperature for strength if,
- insufficient time is given for warming up the windscreen before take-off, or
- the temperature is too high because the aircraft has been parked in the sun.

Working Group

C-1 That, in support of (i) and (iv) of the terms of reference, members should supply to the Chairman of the Working Group,
(a) results of any bird impact structural testing together with geometric details which have been completed by their organizations.
(b) details of any future testing programmes by their organizations.

C-2 That, in support of (ii) and (iii) of the terms of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

C-3 That the Analysis Working Group be reminded of the need for adequate information on the spatial distribution of birds within a flock for the large bird sizes to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike structural requirements.

C-4 The Analysis and Structural Testing Working Groups recognize the need for adequate information on the spatial distribution of birds within and between flocks to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present singel bird strike structural requirements.

3. Progress Report

No additional information against Recommendations C-1 and C-2 has been made available since the last meeting. Recommendation C-3 is deleted since this need is recognized by Recommendation C-4.

Recommendation D-1 is deleted as action had been taken by the Group by appointing the following persons to be responsible for providing the necessary liaison between their countries activities and the Group.

France - M. Besse, Marcel Dassault
Germany - Mr. Wester, MBB
Netherlands - Mr. Van der Spek, RLD (on advise from Netherlands Dept. of Civil Aviation)
Sweden - Mr. Mobärg, SAAB
U.K. - Mr. Richards, CAA

For other participating countries the respective chairmen of the national bird strike committees of those countries will be regarded as the appropriate contacts for the Group.
The remaining Recommendations, D-2, C-1, C-2 and C-4 are retained as committee Recommendations.
The following is a summary of the discussions held during the meeting:

1. The FAA announced the setting-up of an Industry group in the US, covering engine and airframe manufacturers, ATA , whose aim is to re-evaluate the FAR bird strike civil airworthiness bird strike requirements and to make fresh recommendations to the FAA by December 1979. It is clear that the main impetus for this is the engine manufacturers concern with the weight penalties presently involved in providing bird impact resistance.

   The FAA will consider these forthcoming proposals in the light of experience and safety objectives. It is possible that this evaluation may require a further test programme to be undertaken to assist the FAA enquiry.

The FAA agreed to provide the BSCE with copies of the Industry's proposals and background material as soon as there are available as they and the Industry are anxious also to seek the support of Europe in this task.

2. The FAA and possibly Industry may fund research into the spatial distributions of bird flocks. The use of radar and image intensification appear to be promising techniques.

3. The USAF reported on the following programme.

(i) Analytical methods for predicting windscreen transparency and back-up structural impact resistance. This has been achieved through a finite element analysis of the stress distributions from which the final mode of failure can be predicted. It relies on the experimental determination of the mechanical strength properties of the structural materials involved, obtained under high strain-rate conditions. Close agreement with test has been achieved in practical application to existing structural designs. The method is intended for preliminary design and confirmatory tests will still be required. It is hoped to extend the application of that method to other structural areas.

The analytical programme is computor based at Wright Patterson Airfield and will be available for Industry application. The Group expressed some doubt in the manner in which the strength qualities of materials could be obtained under dynamical conditions and wished to have more details on this aspect as it appears to be one of the most important ingredients of this method. A seminar will be held early in 1980 on the use of the programme. Details will be sent to BSCE.

(ii) The statistical method for evaluating the risk of bird strike for an aeroplane on a given mission prifile related in WP 18 was described. For this it is necessary to have knowledge of the frequency distribution of bird size and aeroplane flight speed, variation in bird impact resistance over the structure and flight profile. Close agreement has been found with experience gained on certain aircraft over a ten year period. The method can be used equally well for predicting the bird size required to meet given safety objectives.

It is the intention of the Group to make the latter type of study when the present bird strike analysis being undertaken by the Analysis Working Group

has reached a sufficiently reliable level of achievement, so fulfiling one of the more important reasons for the collection of bird strike statistics by BSCE.

(iii) A handbook is in the final stage of preparation on guidance on the design of transparencies and surrounding structure. This will be made available to BSCE for comment.

(iv) Similarly, a handbook is being prepared on test methods for bird impact. One of the techniques described is the use of "moiré" patterns obtained from test for the analytical prediction of structural deflection. This will also be made available to BSCE for comment.

4. A presentation of WP 22 including a film was made by CEP, France on the development and certification of the CFM 56 engine in respect of foreign object ingestion. A similar programme has been made on a recent Turbomeca engine.

5. The STAe, France announced a programme of bird impact tests to be made on aluminum and titanium alloy flat sheets, reinforced with stringers and intercostals. The purpose is to measure forces and deflections due to impact, from which the theory expounded by Marcel Dassault in their paper presented at BSCE 13 on the estimation of damage following penetration will be tested.

   If the theory is substantiated it will be possible to use it to complement the prediction of penetration speed with guidance on the associated extent of damage.

6. A test for research purposes has just been completed by CEAT, France on the impact resistance to an 8 lb bird of an Airbus tailplane. The results will be available for comparison with the design criteria already established for smaller birds.

7. The MBB regretted that after further enquiry it has not been able to produce the details promised on the testing previously described on the Hansa Jet and Transall aircraft radomes and windscreens. The scope for providing these details should be improved in future test programmes.

8. SAAB confirmed that the projected tests on a Viggen JA 37 will take place as planned in Autumn 1980 and the results will be made available to the Group.

No progress was reported on the preparation of the manual on design guidance, but following

the meeting France and the UK agreed that the first draft will be prepared by the UK based on RAE Report TR 72056. This will be deemed to cover also the structural configurations covered by the CEAT tests reported by M. Delor, with stated limitations imposed by these configurations and the scope of the combined test programmes, including bird weight up to 4 lb. It is hoped to make some cautious extension of the use of these criteria up to 8 lb bird size following examination of recent tests completed by France and the UK.

It was also agreed that it should be emphasized that the use of the criteria is for preliminary design and unless reasonable margins are predicted in structural locations where the consequences of penetration could be serious, testing for final proof of capability will be necessary.

In respect of windscreen transparencies STAe, France agreed that it would advise on the suitability of the UK proposed criteria reported at BSCE 12 after comparison with the criteria based on CEAT tests reported by M. Delor.

4. Proposed Committee Recommendations

1. That the attention of pilots and operators should be continued to be drawn to the deterioration in bird impact resistance of windscreens which rely on the maintenance of an optimum temperature for strength if,
   - insufficient time is given for warming up the windscreen before take-off, or
   - the temperature is too high because the aircraft has been parked in the sun.

2. That, in support of (i) and (iv) of the terms of reference, members should supply to the Chairman of the Working Group,
   (a) results of any bird impact structural testing together with geometric details which have been completed by their organizations.
   (b) details of any future testing programmes by their organizations.

3. That, in support of (ii) and (iii) of the terms of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

4. The Analysis and Structural Testing Working Groups recognize the need for adequate information on the spatial distribution of birds within and between flocks to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike structural requirements.

List of participants at Structures Working Group

Participant	Organization
P.F. Richards	CAA (UK) Chairman
M. Mobärg	SAAB-SCANIA Sweden
Barrere	Centre d'Essais des Profulseurs France
Miss Neveux	STA/EG
J. Besse	Avions M. Dassault - Breguet Aviation France
Wolf E. Wester	MBB - Hamburg
G.H. Capsey	ECAC (observer)
Sven Harald Andersson	Linjeflyg AB Sweden
Kjell Nilsson	IATA Geneva
Bertil von Schantz	Board of Civil Aviation Sweden
Ralph Speelman	USAF Air Force Flt. Dyn. Lab - USA
John Thorpe	U.K. CAA
Manfred Reif	BWB-ML, München - Germany (German Military Certification Agency)
Biemond J.	Amsterdam Airport Schiphol Airport Authotiry
Attig	IGAC 246 Rue lecourbe - Paris 15
Gautier F.	IGAC 246 Rue lecourbe - Paris 15

Excursion to Amsterdam Airport Schiphol

SECTION 4.

PAPERS PRESENTED.

Working papers presented at the main meeting.

Nr.	Title
WP 3	The first ten years of BSCE (V.E. Ferry, France).
WP 4	A forecast system for bird migration in Sweden (Bertil Larsson and Thomas Alerstam, Sweden).
WP 5	Code of practice of Bird Strike Committee Europe (L.O. Turesson, Sweden).
WP 6	American initiative in birdcontrol on a national scale (M.J. Harrison, United States of America).
WP 7	Geographical influence on flights of migratory birds in South East of France (M. Laty, France).
WP 8	A new method of studying bird migration (S.A. Gauthreaux, United States of America).
WP 9	The predicatbility of spring migration of snow geese across Southern Manitoba, Canada (H. Blokpoel, Canada)
WP 10	Effect of light beams on birds (F.J. Verheyen, The Netherlands).
WP 11	Bird Strikes 1977 Civil a/c (J. Thorpe, United Kingdom)
WP 12	Bird Strikes 1977 Mil a/c (P. Kingston, United Kingdom).
WP 13	New procedures for evaluation of radarinformation (J. Becker, Federal Republic of Germany).
WP 14	New procedures for publication of bird warnings and forecasts (J. Hild, Federal Republic of Germany).
WP 15	Regulations for the bird strike representatives of the civil airports in the Federal Republic of Germany (W. Keil, Federal Republic of Germany).
WP 16	Experiences about the bird strike regulations of the Federal Ministry of Transport since 1974 (specially about the biotop experiences). (W. Keil, Federal Republic of Germany).
WP 17	Laser and symbolic lights on birds in order to prevent bird aircraft collisions. (K. Mossler, Sweden).
WP 18	A probalistic model of evaluating birdstrikes threat to aircraft crew enclosures (B.S. West, R.E. Wittman, United States of America).
WP 19	The quality of identification: a microscopic key to determination of featherremains (T.G. Brom, L.S. Buurma, The Netherlands).
WP 20	The quality of identification: its effects on birdstrike statistics (T.G. Brom, L.S. Buurma, The Netherlands).
WP 21	Pattern of bird migration over the Netherlands: a classification illustrated with radarfilm (L.S. Buurma, The Netherlands).
WP 22	Certification aux ingestions du moteur SNECMA/GE CFM 56 (France).
WP 23	Solution propre à la France: sensibilisation des personnels (M. Briot, France).
WP 24	Tests of a device for the protection of aircraft gas turbine engines against bird strikes (M.S. Wooding, Warton, United Kingdom).

Nr.	Title
WP 26	Is it necessary to destroy birds on aerodromes? (V.E. Jacobi, U.S.S.R.).
WP 27	Information to pilots about the danger of bird strikes (C. Bakker, The Netherlands).
WP 28	ICAO Activities Related to Bird Strikes (K.K. Wilde, ICAO).
WP 29	Bird Risk and Air Safety (G. Marcal, France).
WP 30	Bird strikes to Aeroflot registered aircraft and some general airworthiness requirements (Dr. Trunov and Mr. Rogatchev, U.S.S.R.).
WP 31	About the procedures aimed at bird strik avoidance (V.E. Ferry, France).
WP 32	Summary of results of spraying with "RETA" repellant at Ben Gurion Airport 1974-1979 (S. Su-Aretz and J. Agat, Israel).
WP 33	Bird control at Helsinki-Vantaa Airport, Finland (S. Kuusela and O. Stenman, Finland).

ADF 616 081

BSCE/14 WP 3

14th Meeting on Bird Hazards to Aircraft (BSCE 14)

The first ten years of BSCE

Vital E Ferry, France

Introduction

During the BSCE 11th meeting it was decided that someone had to review previous reports and try to prepare a summary for the benefit of participants who have not been in position to attend all previous meetings.

It was also decided to prepare a list of all working papers delivered during these meetings arranged by matters using the present working group distribution as a reference.

As the only complete set of reports (or almost complete) was in the hands of the then Chairman of BSCE, it was decided that this task should be discharged by the chairman with a fixed deadline.

However, the ever increasing number of lectures imposed a limitation to this research work and it was felt that a covering period of 10 years could offer the best compromise and offer a relatively large coverage of the BSCE past deeds.

Nor was it possible to allow each working paper to W Groups as these groups have been nominated at different periods of time and papers very often cover more than one field of research. So deliberately it was left to the reader to guess to what W G the lecture applies (some of them are yearly reports with general conclusions and the total list covers almost 120 lectures).

Present working paper is divided into 3 parts

part 1 short history of BSCE 1966 to 1975

part 2 list of lectures (omissions unavoidable, accept apologizes)

part 3 list of the recommendations agreed at the 1st meeting (forming)

Part 1 Short history of BSCE (as recorded by annual meeting reports)

1966: Meeting in Frankfurt am Main from 20 to 21 July 1966 called by Dr Hild. Representatives of airforces from Europe invited.
No record of lectures given except for "Statistics concerning bird strikes at the Belgian Air Force 1956 to 1965. 14 conclusions approved by participant (see part 3).

1967: Meeting in Den Haag from 5 to 8 June 1967
Chairman Lt Colonel TWIJSEL
Record of lectures given, and minutes published to be followed each meeting.
23 participants, 8 countries, 5 lectures
8 conclusions approved. Working group Bird/Radar/Weather established.
Terms of reference BSCE defined and agreed.

1968: Meeting in Brussels on 6 and 7 June 1968
Chairman Lt Colonel TWIJSEL
40 participants, 12 countries (Spain, Sweden, Norway first time) 13 lectures 1 film (USA)
Meeting open to every western country interested
No conclusions drawned
Working group Bird Movement established

1969: Meeting in Den Haag from 3 to 5 June 1969
Chairman Lt Colonel TWIJSEL
29 participants- 10 countries (Switzerland first time)
12 lectures
No conclusions drawned

1970: Meeting in Cologne on 9and 10 June 1970
Chairman Lt Colonel TWIJSEL
36 participants - 11 countries (Italy first time)
6 lecture - 3 films
2 conclusions approved
New chairman elected: Major Schneider
Transmission working group established
NATO grant seeked.

1971: Meeting in Copenhagen on 15 and 16 June 1971
Chairman Lt Colonel SCHNEIDER
46 participants - 14 lectures - 1 film
8 conclusions drawned - working groups terms of reference reviewed, chairman elected
(report published as a complete brochure)
Radar working group officially formed.

1972: Meeting in London on 6 and 7 of June 1972
Chairman Lt Cl SCHNEIDER
57 participants (USSR first time) 13 lectures
14 conclusions
"Aerodrome" W G and "Analysis" W G formed with chairman elected
Chairman BSCE reelected for a 2 years period - last meeting attended by M S Kuhring

1973: Meeting in Paris on 23 and 24 of June 1973
Chairman: L^t C^l SCHNEIDER
70 participants - 16 lectures - 1 film
Reports of activities of BSCE and W G's delivered for the first time. Formal recommendations appeared, one from the Committee and various from W G (21 totally).
W G "Transmission" changed to "Communications"

1974: Meeting in Frankfurt am Main from 18 to 21 June 1974
Chairman: L^t Colonel SCHNEIDER
71 participants - 16 lectures
2 recommendations from the Committee - 19 from W G
New chairman elected for a 2-years period: Mr V Ferry.

1975: Meeting in Stockholm from 9 to 13 June 1975
Chairman: V FERRY
81 participants - 23 lectures
21 recommendations adopted by the Committee
"Structural testing" W G formed
First time a cover in colours appears.

Part 2 List of lectures 1966-1975

Year	Author	Title	Reference
1966		Statistics concerning bird strikes at the BAF 1956 to 1965	1/1-
1967	E A SEAMAN	Recent Research findings of U.S.A.F. in Bird control at airfield	II/1
	C W STORTENBACKER	Birdstrike Problems at Schipol airport	II/2
	W KEIL	Ecological Research at Hamburg airport	II/3
	P VAN DER WIELEN	Measures to avoid Birdstrikes during flight	II/4
	W KEIL	First results on crane migration	II/5
1968	M S KUHRING	Progress in the effect of micro-wave radiation.	III/1
	J W SLOT	Hawk at Leeuwarden Airbase	III/2
	H R FINELY	Birdweight and airport manual	III/3
	J HILD	Agricultural investigation for expelling birds from German bases	III/4
	D W STORTENBACKER	Progress report of Schiphol airport	III/5
	V FERRY	Birdwarning with the aid of airfield radar	III/6
	J HILD	Vulnerability maps	III/7
	E W HOUGHTON	Research on the radar properties of birds in UK	III/8
	V E F SOLMAN	Amino acid contents of birds	III/9
	J HILD	Reports on birdstrikes in Germany	III/10
	VAN BERWIELEN	Report on the 2nd Radar W G meeting	III/11
	BROADFOOT	Progress in the detection of bird movements at Gold Lake	III/12
	J HILD	European Bird Migration Map	III/13
1969	J HILD	Progress report European Bird Movement WG	IV/1
	M S KUHRING	Local and migratory movements of birds	IV/2
	H N WOLLESWINKEL	Bird impact capacity of civil aircraft	IV/3
	J HILD	Birdstrikes in the GAF during 1968	IV/4
	J P C DE BRUIN	Bird warnings and birdstrikes in the RNLAF	IV/5
	E W HOUGHTON	Radar echoing areas of birds	IV/6
	J HILD	Agricultural investigations on German air bases	IV/7

Date	Author	Title	Reference
1969	J HILD	Meteorological aspects on agri-cultural methods of scaring birds	IV/8
	F H M MIKX	Hawks at Leeuwarden air base	IV/9
	J HILD	Bird fluctuations on airfields during the year	IV/10
	J HILD	Some investigations on the efficiency of radiation and teargas	IV/11
	BSCE survey	Restrictions to flight traffic during bird migration in 1969	IV/12
1970	J HILD	Birdstrikes in Germany 1969	V/1
	C F A VAN BEZOOIJEN	Birdwarning and birdstrikes in the RNLAF 1969	V/2
	J HILD	New orders to the GAF for prevention of birdstrikes	V/3
	J HILD	Ecological research at Decimonnannu airfield (Sardinia)	V/4
	E W HOUGHTON	Bird/weather and anomalous propaga-tion echoes on radar	V/5
	J HILD	German system of visual observation of bird migration	
1971	T BROUGH	Experimental use of long grass in the UK	VI/1
	H LIND	An attempt to reduce Herring Gull population on Saltholm	VI/2
	G MØLLEN	Use of Distress Calls for scaring birds on airfields in Norway	VI/3
	J HILD	Mixtures of grass-seed for airports	VI/4
	F RODRIGUES DE LA FUENTE	Falconry for the control of birds on airports	VI/5
	group	Progressreport from Belgium	VI/6
	W KEIL	Birdstrike situation in Lufthansa 1970	VI/7
	J HILD	Birdstrikes in GAF -1970	VI/8
	W KEIL	Exchange of information about birdstrikes	VI/9
	V E F SOLMAN	Report from the Bird/Radar/Weather W G	VI/10
	H NOER	Recent Development of the Danish Bird Migration Forecast system.	VI/11
	E W HOUGHTON	ATC and the bird radar surveillance without tears	VI/12
	B BRUDERER	Bird/Weather/Radar work in Switzer-land	VI/13
	J HILD	Report about bird Movement W G	

Date	Author	Title	Reference
1972	F BLACKWELL	Use of bird activity modulation waveforms in Radar identification	VII/1
	M LOUETTE	The Distribution of the black headed gull in Belgium	VII/2
	E W STORTENBECKER	Bird dispersal with acoustical and visual means	VII/3
	V E JACOBY	Ornithological researches in the USSR (Birdstrike problems)	VII/4
	B BRUDERER	Bird problems as discovered at Zürich airport	VII/5
	W KEIL	Ecological research in Aerodrome traffic zone and its results	VII/6
	M S KUHRING	Projects of the Canadian BSC	VII/7
	J HILD	Bird hazard maps for Europe	VII/8
	J HILD	Bird strike situation in GAF	VII/9
	J O GEZELIUS	Bird-aeroplane collisions at low altitudes	VII/10
	W KEIL	An analysis of the bird strike reports from Lufthansa	VII/11
	J THORPE	Analysis of bird strikes	VII/12
	V E FERRY	Radar observation methodology and procedures used by ATC	VII/13
1973	M LOUETTE	Bird migration forecasting	VIII/1
	R ROBIJN	Computational procedure for bird migration forecasting	VIII/2
	J HILD	Result of bird movement W G	VIII/3
	J HILD	Procedure of birdstrike warning forecasting advisory in GAF	VIII/4
	M LATY	Information to pilots	VIII/5
	E W HOUGHTON	Highlights of the NATO-Gibraltar bird radar study	VIII/6
	M CLAUSEN	Electronic counting of birds	VIII/7
	J BECKER	General considerations about entomological investigations	VIII/8
	J HILD	Special considerations about handling of grassland areas	VIII/9
	J KARLSSON & L-O TURESSON	Preliminary works before the opening of Malmö/Sturup airport.	VIII/10
	J THORPE	Six years of birdstrikes in the UK	VIII/11
	E SCHNEIDER	The result of prevention of bird-strikes in Denmark	VII/12
	J HILD	Public relations in Germany	VIII/13
	G LID	Bird strike problem and public relations in Norway	
	M LATY	Research activities on bird problems in France	

Date	Author	Title	Reference
1973	H BLOKPOEL	Presentation of a book on bird hazard problems	VIII/16
1974	A SALTER	Military aircraft birdstrike analysis 1972	IX/1
	J THORPE	Birdstrikes during 1972 to European registered civil aircraft	IX/2
	V E JACOBY	Introduction to birdstrikes in USSR	IX/3
	V A GORYACHEV	Analysis of birdstrikes in USSR civil aviation	IX/4
	W POLITT	The problem of birdstrikes in statistics and analysis	IX/5
	J HILD	The bird strike problems in GAF (Two lectures)	IX/6
	B BRUDERER	Multiple regression analysis of weather and migration data	IX/7
	J RABØL	Forecast models for bird migration intensities in Denmark	IX/8
	V E F SOLMAN	Progress made in Canada	IX/9
	M LATY	Risks for birdstrikes created by black headed gulls on Nice/Cote d'Azur air-port.	IX/10
	T ALERSTAM	Visible bird migration and weather	IX/11
	M LOUETTE	Lapwing investigation on Beauchevain airport	IX/12
	M LUNIAK	Polish ornithological investigations and bird strike problems	IX/13
	F R HUNT	Radar Detection of birds in an Operational Environment	IX/14
	F BLACKWELL	Analysis and classification of bird flight and Echo data from Radar	IX/15
	T BROUGH	Estimating the physical dimensions of birds by radar	IX/16
1975	E W HOUGHTON	A radar study of wild duck	X/1
	J THORPE	Birdstrikes during 1973 to European registered civil aircraft	X/2
	A SALTER	Military aircraft birdstrike analysis 1973	X/3
	J F STOUT	Dispersal of gulls from the airport environment	X/4
	J F BOOMANS	Synopsis of the organisation and activity of BSC Belgium 74-75	X/5
	J HEIRMAN	Further lapwing investigations on Beauchevain	X/6
	J HEIRMAN	A Belgian bird strike risk map based on ratio bird per area	X/7
	G SOETENS	Experminental bird counting with a real time computer	X/8

Date	Author	Title	Reference
1975	M LATY	The blackheaded gulls with their assigned quarters in Nice	X/9
	H BLOKPOEL	Prediction of the spring migration of snowgeese	X/10
	H CESBRON-LAVAU	Global statistical approach of the birdstrike	X/11
	L STAHL	Studies of birdreactions caused when exposed to laser light	X/12
	L S BUURMA	Birdstrike prevention success and and malaise in the RNLAF	X/13
	A H JOENSEN	European bird hazard maps	X/14
	S SUARETZ	Bird strike problem at Ben-Gurion airport	X/15
	T ALERSTAM	Spring migration of cranes over southern Scandinavia	X/16
	J KARLSSON	Bird strikes in Sweden 1967-74	X/17
	A HOLM JOENSEN	The use of waterfowl count data in birdstrikes work in Denmark	X/18
	F R HUNT	Automatic warning of hazardous bird conditions	X/19
	A ROED	Bird strike problem from air-technical point of view	X/20
	S ULFSTRAND	How many birds are there	X/21
	S L SEUBERT	Current activity concerning the US Bird/plane strike problem	X/22
	H BLOKPOEL	Bird hazards to aircraft	X/23

Part 3 List of recommendations agreed at the first meeting of BSCE

Meeting of Bird Strike Committee held at Frankfurt/Main on 20/21 July, 1966

Conclusion

The representatives of the countries, who attended the Bird Strike Committee on 20/21 July, 1966 in Frankfurt/Main give the following recommendations:

1. The methods and possibilities for scaring birds off the airbases developed and practiced by member countries should be regarded as a guidance for the respective measures to be taken by the other nationel Committees for Flight Safety.

2. When taking effective measures against birds on airbases the local general biological conditions of the area concerned should be taken into consideration. This is most important if they are to be of real value.

3. The Basic Chart indicating areas of hazard as well as bird migration routes in the Federal Republic of Germany drawn up by GAF will be placed at the disposal of all interested nations. These nations should draw up corresponding charts of their own countries and place them at the disposal of the other Committees respectively of the Flight Safety Committee, so that a European map showing the areas with a pronounced hazard to flight safety through birds and the migration routes will eventually be drawn up which can be displayed in the briefing room respectively in the meteorolgical stations for the general information of all pilots (Time limit for the submission of these charts 31st December, 1966).

4. Exact details on bird flight altitudes as well as the correlation between migration and meteorological conditions are essential. Canada would be prepared to place their research and observation results at the disposal of the other nations. As these cannot automatically be applied to European conditions, all interested European countries are requested, as far as this is feasible, to do observation and research work of their own, in close cooperation with their respective meteorological services. In doing so, factors like wind and temperature as well as air pressure, visibility, humidity and stability of the atmosphere should be taken into consideration.

5. The countries concerned are prepared, as far as they are in a position to do so, to inform the various national flight safety agencies of the partner countries via teleprinter of all bird migration observed during the spring and fall migration periods, giving the following details: date, time, size of flock, flight level and direction. In order to do the preliminary work necessary for this, a working party is formed on which the following nations resp national activities are going to be represented: R Neth AF" US Germany, RCAF, RAF, and Germany. These countries were

selected because of problems of distance, but other countries, are obviously welcome to participate at any time. This working group will issue specific recommendations from time to time to all countries concerned. Nations are requested to inform the working group in the near future of the possibilities of bird observations in their respecitve countries and of the practicability of transmitting relevant information.

6. The object of the observation of and reporting on bird migration will be to issue a forecast; this will, however, only become possible if and when the influence of weather conditions on the behaviour of the birds has been investigated.

7. It is recommended that each of the countries concerned should set up radar observation of bird migration; it is understood, however, that much will depend on the local and technical possibilities and conditions in the various countries. The Canadian methods of bird observation over radar can be taken as a guidance. If we are to gain knowledge of bird movement, as many widely spaced radar stations as possible, will be required.

8. It would seem to be necessary to take more and better measures against birds in hangars. Canada has done some work in this field.

9. All partners are agreed that an extensive exchange of information on the results of research work and observations, as well as on the measures taken against bird damages to air traffic is an urgent necessity. Circulars and reports on this subject might be forwarded to the national representatives from time to time.

10. The representatives of the nations taking part in today's meeting consider it advisable that a specialist should be appointed in each of the countries concerned to study the problems of bird strikes, as far as the military is concerned, and to evaluate the results of his studies and of (radar) observations.

11. The evaluation of damages to aircraft by birds on the basis of realiable and extensive reporting is an essential prerequisite to the preparation of useful proposals and suggestions to the technical agencies.

    The reports on bird strikes in civil aviation are sent to ICAO and also to the Canadian National Research Council; those on the military sector are collected and evaluated by GAF, Director Flight Safety. Evaluations results and conclusions are reported at the respective meetings.

12. The future international cooperation should not be limited to the items mentioned under 8), but should also extend to personal contacts and exchange of information between the representatives of neighbour countries who mostly are faced with similar problems.

13. The German Board would be prepared to advice the Armed Forces of Friendly Nations stationed in Germany on these and related problems, should such advice be requested.

14. The next meeting is envisaged to take place in spring of 1967. Amsterdam was suggested as the place for this meeting. A final decision about meeting place will be taken during the next meeting of the Air Force Flight Safety Committee in Sept. 1966, at London.

Frankfurt, 21st July, 1966

AD F616 082

WP4.

A FORECAST SYSTEM FOR BIRD MIGRATION IN SWEDEN

Bertil Larsson Swedish Air Force, Krigsflygskolan, S-260 70 Ljungbyhed, Sweden

Thomas Alerstam University of Lund, Dept. of Animal Ecology S-223 62 Lund, Sweden

Introduction

A preliminary forecast system for bird migration has been in use in Sweden during two test periods, in the autumns (Aug. - Nov.) of 1977 and 1978. Daily bird migration forecasts have been issued during these periods to military as well as civil air fields and authorities.

In this report we will briefly describe the operational routines and also present an evaluation of the forecast system based on the experience from the two test periods. After critical testing of the bird migration forecast system, the Swedish Air Force has decided to use the system regularly in the next few years, and to support parallell work to refine and develop further the system.

The biological basis of the forecast system

The forecast system allows predictions to be made about bird migratory intensity. These predictions are based on the relationship between migratory intensity and weather, so that, once the weather is given (predicted by meteorologists' forecasts), the most probable migratory intensity of a certain bird species at a certain date and time of day can be calculated.

The present forecast model is mainly based on extensive multivariate analyses of the relationship between weather and daily bird migratory intensity as recorded by eleven years' observations at Falsterbo in South Sweden. The analyses comprise more than thirty different weather variables and fifteen bird species of widely different kinds (cf. Table 1). Daily migratory intensities during each species' peak migratory period have been grouped into four different classes and related to weather by stepwise multiple discriminant analyses. The classification functions given by these analyses are then used in the forecast system for the purpose of predicting migratory intensity.

The detailed results from these analyses of the bird migration data from Falsterbo, together with a biological interpretation and discussion, has been published in:

Alerstam, T. 1978. Analysis and a theory of visible bird migration. - Oikos 30:273-349.

Table 1 is a summary of the overall correlation coefficients ("canonical correlation coefficients") between weather and different kinds of bird migratory intensity, indicating the degree of covariation between these factors.

Table 1. Canonical correlation coefficients from discriminant analyses of daily bird migratory intensity in relation to weather. Based on Alerstam (1978)

Eider	-August	0.33
Eider	-October	0.51
Common buzzard		0.61
Honey buzzard		0.59
Sparrow hawk		0.61
Black-headed gull		0.45
Wood pigeon		0.66
Swift		0.61
Swallow		0.58
Hooded crow		0.68
Jackdaw		0.70
Yellow wagtail		0.63
Starling	-August	0.70
Starling	-October	0.55
Chaffinch/Brambling		0.61
Siskin		0.48
Linnet		0.69

Further analyses by the same method are presently carried out and planned on the basis of extensive data on bird migration from other field observation sites than Falsterbo and for other kinds of birds.

The results of the analyses of the Falsterbo migration data form only part of the present forecast system. The system also takes into account information about the daily time distribution as well as seasonal and geographical distribution of the migration of the different species. This information is based on field observations of bird migration at many different sites as well as radar observations from a lot of stations in the south part of

Sweden. Since 1972 the Air Force and Board of Civil Aviation have supported a project to extend the knowledge, mainly by radar studies, of the distribution of migrating birds in space and time. Complementary work for species and regions of particular interest remains to be done in the forthcoming years.

Forecast Model

1. General back-ground

The results obtained by the method described above have been used to develop a warning system for bird migration. The aim is to predict migration activity, with sufficient accuracy, one day in advance by using weather forecasts as input. One preliminary model has been in use during two test periods, from the beginning of August to the middle of November in 1977 as well as in 1978. The bird migration forecasts were distributed by telefacsimile and teletype to all military and civil airports concerned. One forecast, in this report called preliminary, was issued one day in advance (Monday to Thursday) and another, called final, in the early morning the same day it was valid (Monday to Friday). The day was divided into four different periods, 07-10, 10-12, 12-14, and 14-17 hrs, and one forecast map was drawn for each of these periods. To make all calculations and comparisons with basic migratory pattern possible within available space of time it is necessary to use a small computer.

2. Weather, Sectors and Species

The southern part of Sweden shows the highest migratory activity and forecasts are presently made for that area only (Fig.1). In order to adapt, as far as possible, the bird forecast to the actual weather situation the forecast area is divided into six sectors (Fig.1). In each sector data from one representative weather observation station (●) are used for the bird forecasts in that sector. Some parameters such as relative humidity, maximum and minimum temperature (O) and upper winds at 850 mb level (x) are taken from other stations common for three sectors each (1,2,3 and 4,5,6 in Fig.1). For the final forecast most weather parameters refer to actual observations made at 05 GMT. For the preliminary forecast, however, all weather parameters have to be predicted for the next

day by a meteorologist.

As the bird migration data are grouped into four intensity groups the intensity predicted on the basis of the results from the discriminant analyses is given by a figure 1 to 4 for each species and sector. The fifteen bird species used in this preliminary model are:

Sea birds : Eider and Blackheaded Gull

Light birds: Chaffinch/Brambling, Swallow, Yellow Wagtail, Starling, Siskin, Linnet and Swift

Heavy birds: Wood pigeon, Jackdaw, Hooded Crow, Sparrow Hawk, Common Buzzard and Honey Buzzard

3. Time and Geographical Distribution

The time and geographical distribution of the migration of different bird species are assumed to be the same as found from several years of visual countings and radar studies. One example (Common Buzzard) can be seen in Fig.2. Similar diagrams and maps are available for all species involved.

If the actual time of year and day falls outside the framed area in Fig.2 (left) the intensity figure is set to 1 (none or weak migration). If it falls within the frame but outside the shaded area the predicted intensity is reduced by one unit. Within the shaded area the prediction based on the discriminant models is not modified at all.

The geographical distribution (Fig.2 right) is transformed to a grid with 252 points (Fig.1). For each grid-point and species a check is made to ascertain that the final intensity figure is not allowed to have a higher value than that given by the geographical distribution for the species concerned.

As a result, there is for each species and period of the day a matrix (consisting of values 1 to 4 at each grid-point) covering the whole area.

4. Resulting Map

The next step is to have a print-out of points, where the intensity is exceeding the threshold for a warning to be issued. The present threshold demands that at least one of the species in a group (sea birds, light birds, heavy birds) must reach intensity 3 before there will be a warning for that group and grid-point. The thres-

hold can of course be changed at the customers request.

The final map (Fig.3) is drawn by hand using the outprint from the computer. The maximum altitude of bird migration, usually estimated from meteorological radars, is added to the bird migration forecasts. Four daily forecast maps for different times of the day are then distributed.

Especially the military pilots are using the information when making their flight planning. The Swedish Air Force has decided that the pilots are not allowed to cross an area with warning without special reasons. As the squadrons are making much of the planning one day in advance it is of course of greatest interest to them that the preliminary bird forecast is as reliable as possible.

5. Evaluation

After two test periods an extensive evaluation has been made. Some of the results will be presented here. The total amount of warnings issued during the autumn in 1978 can be seen in Fig. 4. The warning threshold used in 1977 was much lower and therefore too many warnings were issued.

The differences between preliminary and final forecasts in 1978 are presented in Fig.5. These differences are of course due to errors in predicting the different weather parameters for the preliminary forecast. In that respect 1977 and 1978 are very much alike. The preliminary bird migration forecast is mainly based on 24 hours weather forecasts. Fig.6 a-d shows these errors in weather predictions and also means and standard deviations. The x-axis in all diagrams is 'observation' minus 'forecast'.

Naturally the most interesting question is: How accurate is the bird forecast? The only place where, at the moment, a relevant evaluation can be done is at Falsterbo, where the final forecast has been compared with actual visual countings (Fig.7). For this comparison, the threshold used in 1978 has been applied to the 1977 data.

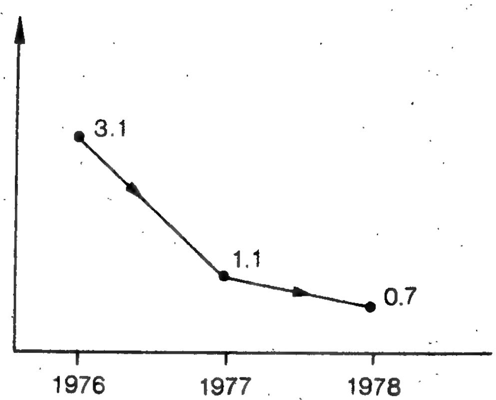
An interesting question is: If we compare predictions from the bird migration forecast system with random distribution of the warnings issued, what would the result be? This is the answer (random figures within brackets).

1977+1978	Sea	Light	Heavy
Forecast correct (%)	61 (49)	70 (61)	82 (53)
Warning unnecessary (%)	25 (31)	14 (19)	6 (21)
Warning missed (%)	14 (20)	16 (21)	12 (27)

In all cases the forecast is better than random but the differences are rather small for the sea and light groups. The sea bird data from Falsterbo used in the discriminant analyses are, however, not completely reliable because most sea-bird migration takes place far south of the counting site. Within the light group two species show very poor results and disturb the result of the whole group. Plans to attain higher accuracy especially for these two groups are presented below.

Evaluation of bird strikes with damage to the aircraft in the Air Force from July to December during the last three years gives a rather positive trend. (The warning system was introduced in 1977.)

Number of strikes with damage/10.000 movements
(July - December)



Future Work and Improvement

The present bird forecast system will run for at least another three years. After that the Air Force will decide whether the system will be permanent or not. Within two years we intend to introduce a limited spring migration forecast model.

Possibilities and need to extend the forecast area to the northern part of the country will be investigated. Already this year we are brushing up the sea bird model by using more representative countings from the east coast of Sweden. At the same time the number of sea bird species will be increased. We also intend to take a closer look at the weather parameters and try to improve the existing model especially for the light species and also for some of the heavy species.

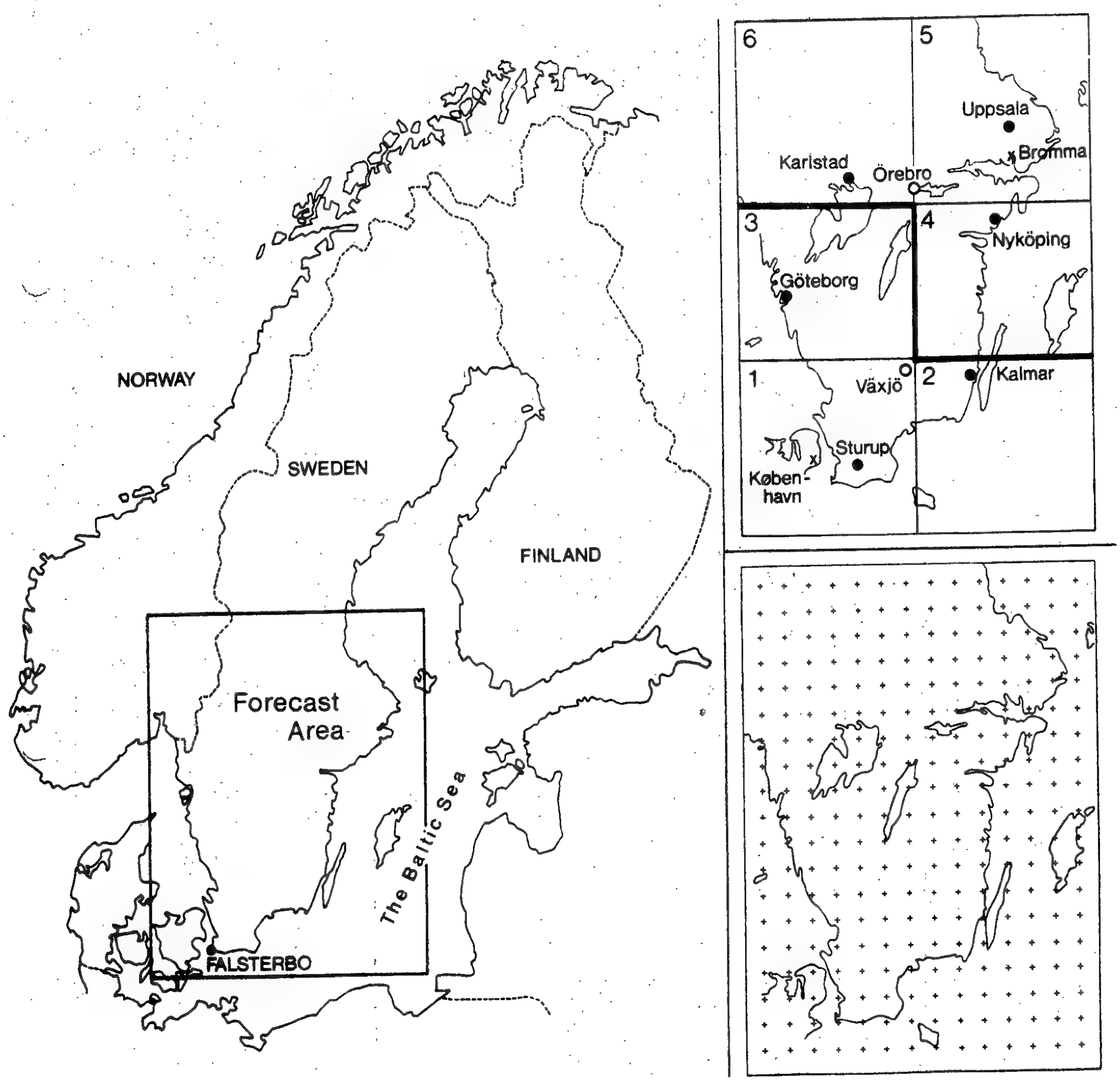
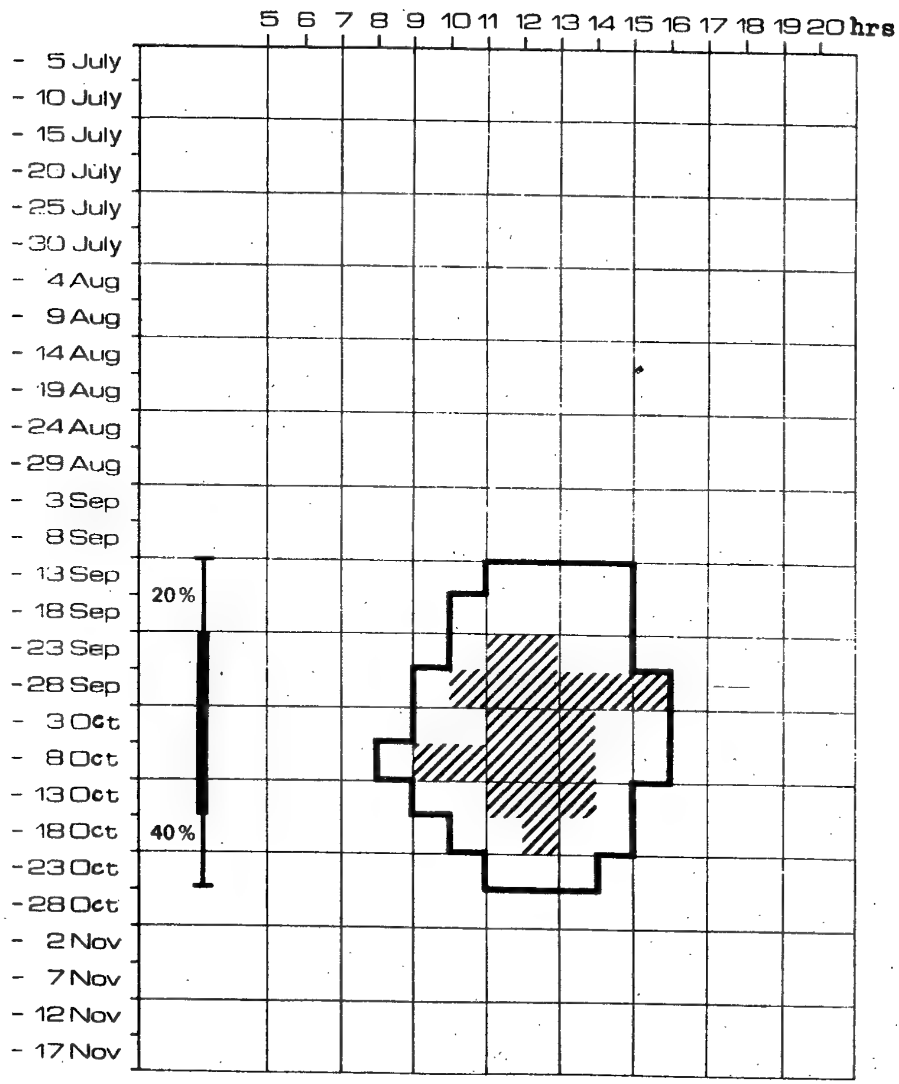
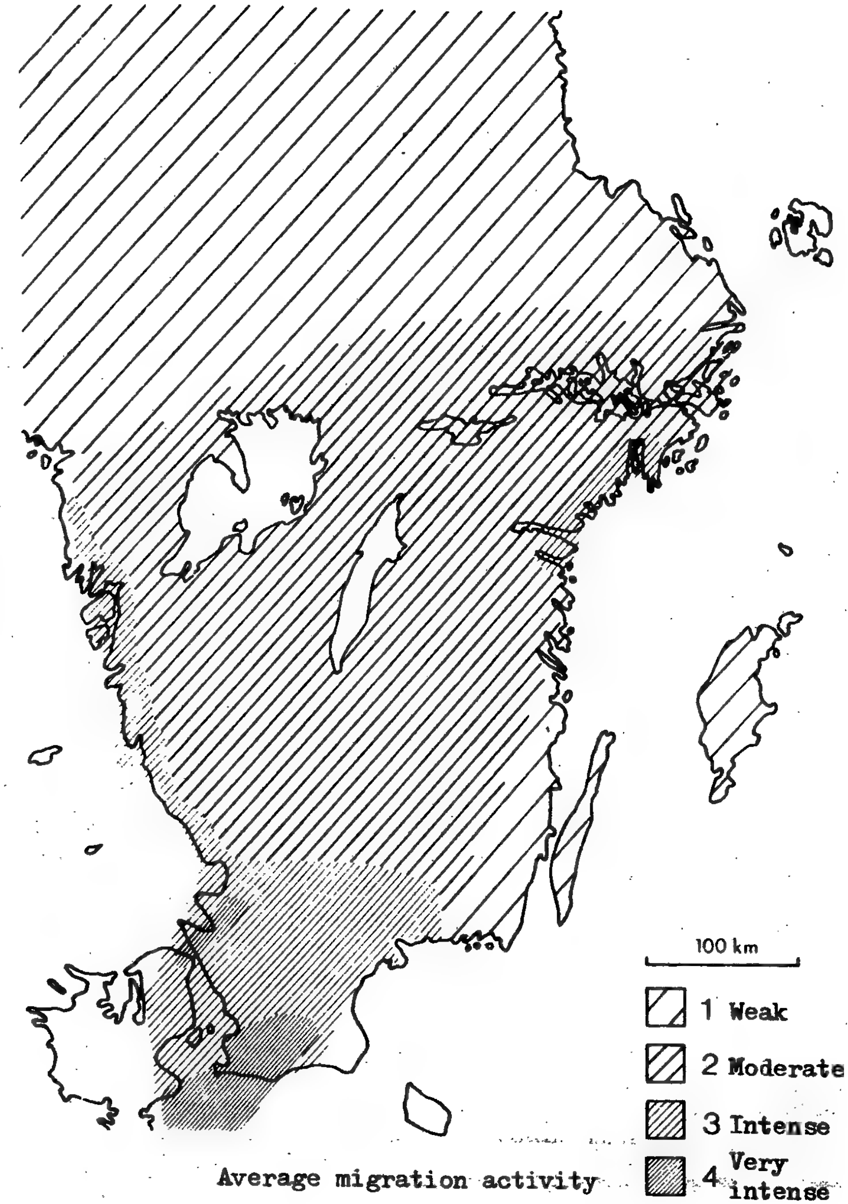

NORWAY
SWEDEN
FINLAND
Forecast Area
FALSTERBO
The Baltic Sea
6
5
Uppsala
Bromma
Karlstad
Örebro
3
4
Nyköping
Göteborg
1
2
Växjö
Kalmar
Sturup
København

Fig. 1

Buzzard

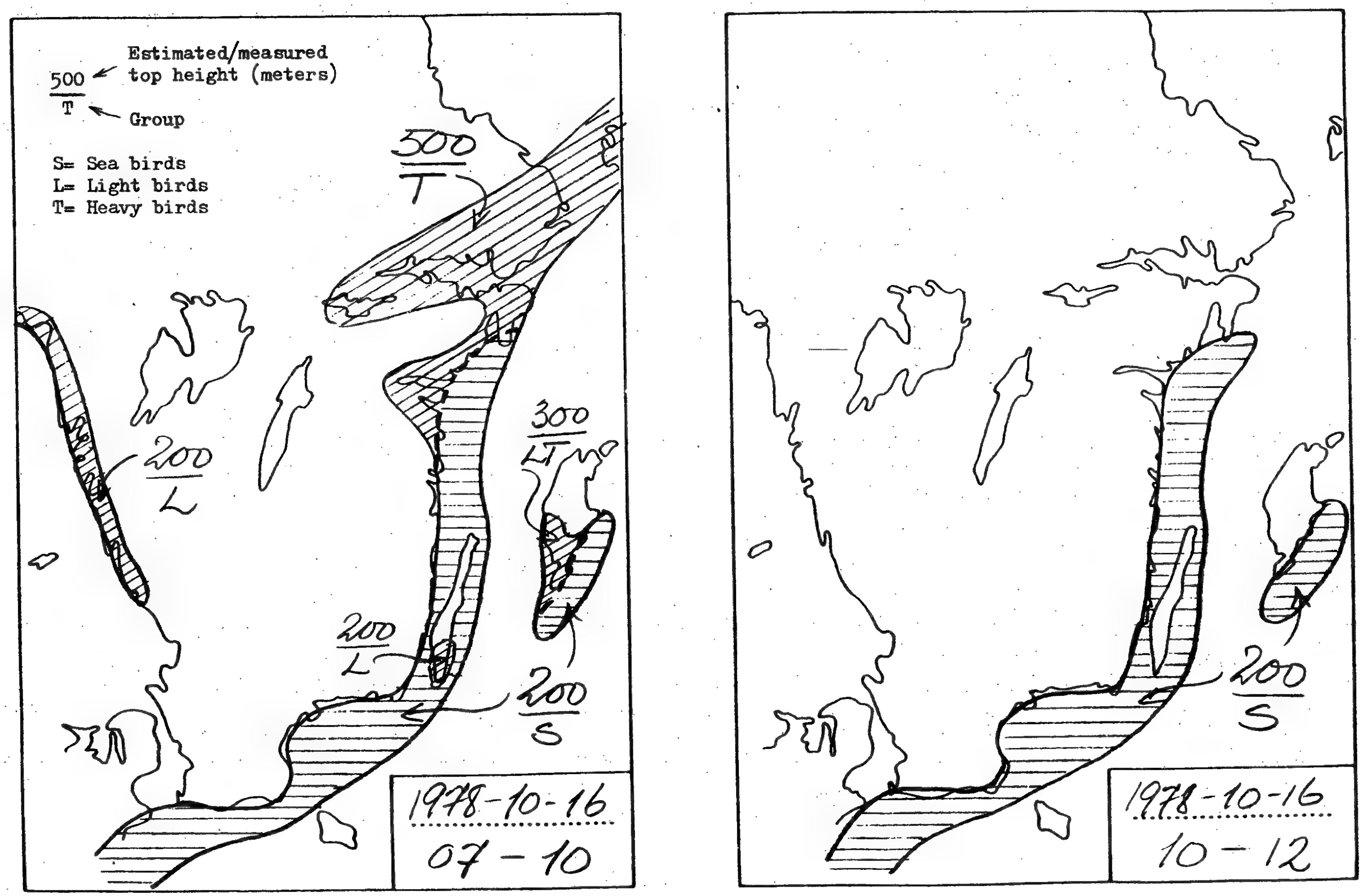


Framed area = moderate/intense migration
Shaded area = very intense migration



Average migration activity

Fig. 2



500 / T
Estimated/measured top height (meters)
Group
S= Sea birds
L= Light birds
T= Heavy birds
500 / T
200 / L
300 / LT
200 / L
200 / S
1978-10-16
07 - 10
200 / S
1978-10-16
10 - 12

Fig. 3

NUMBER OF DAYS WITH WARNING (%) 1978

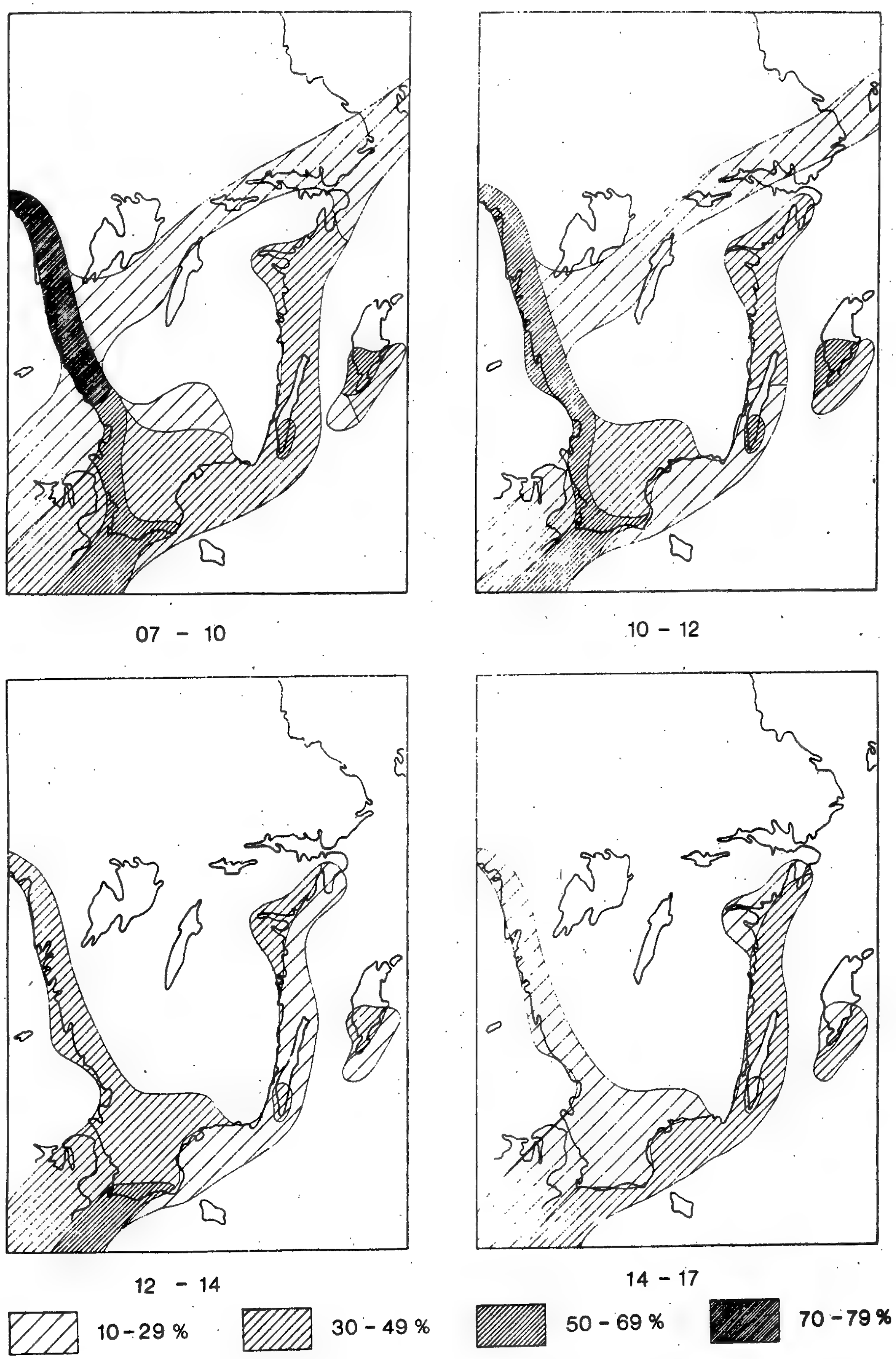


Fig 4

DIFFERENCES BETWEEN PRELIMINARY AND FINAL FORECAST

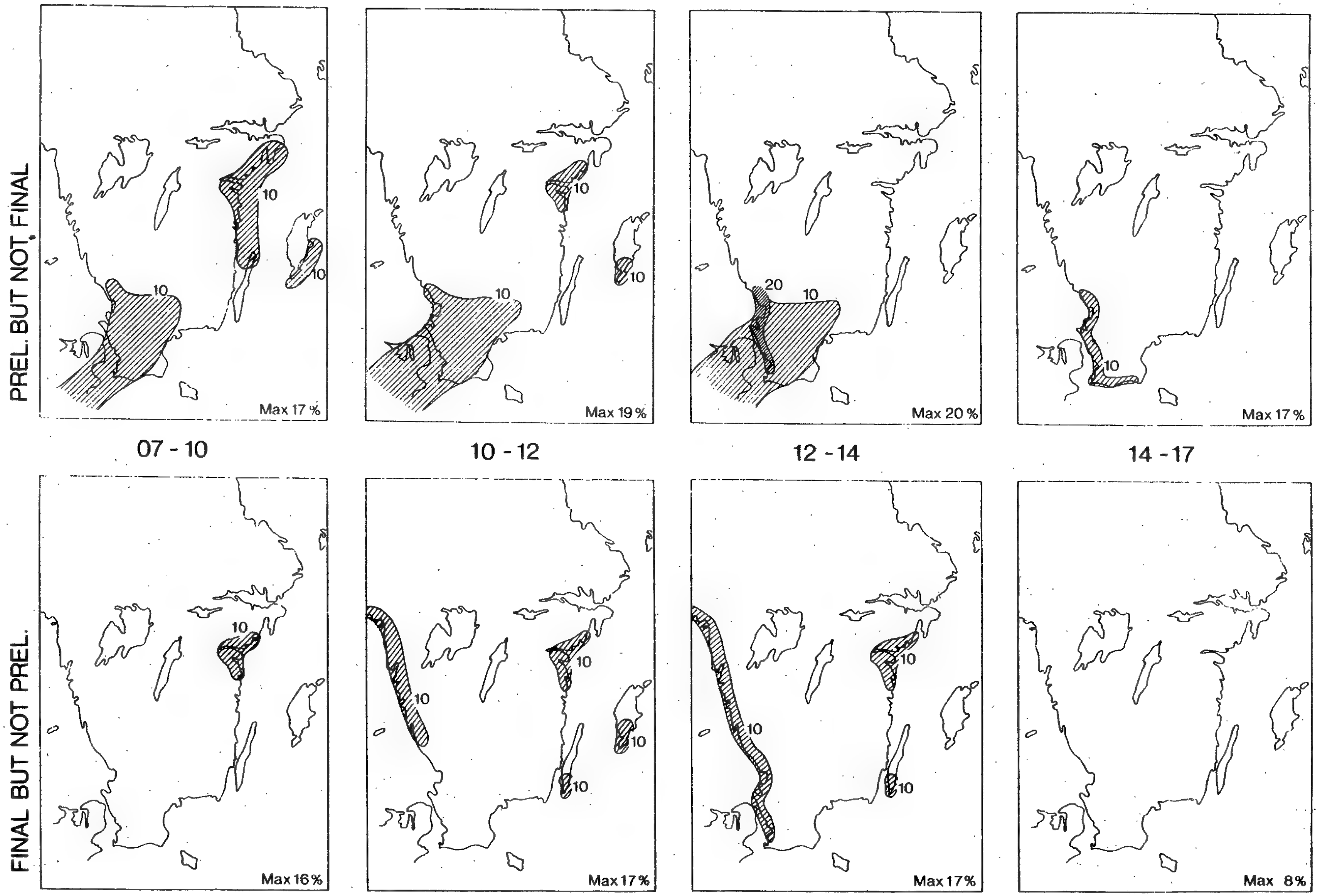


Fig. 5

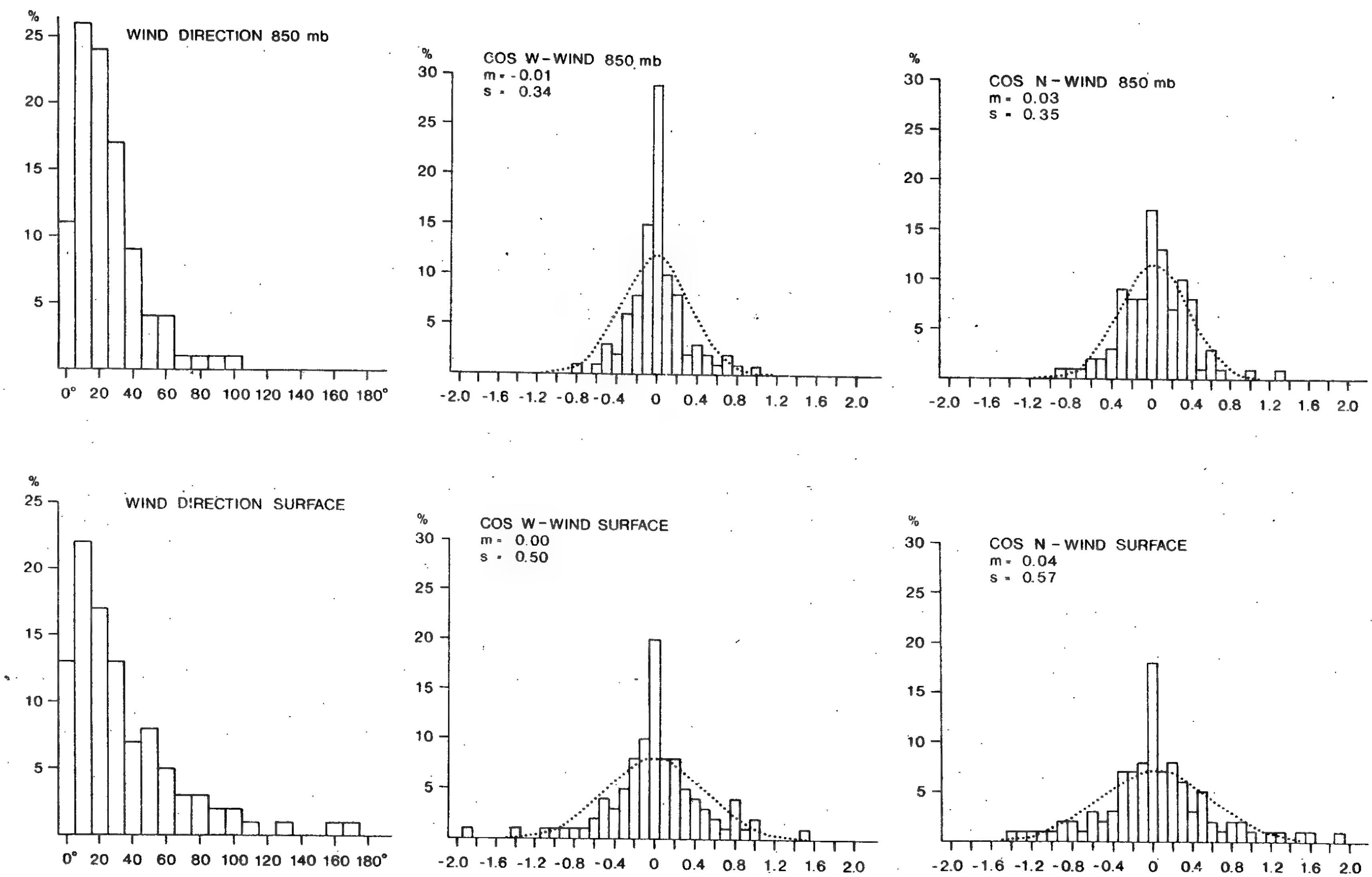
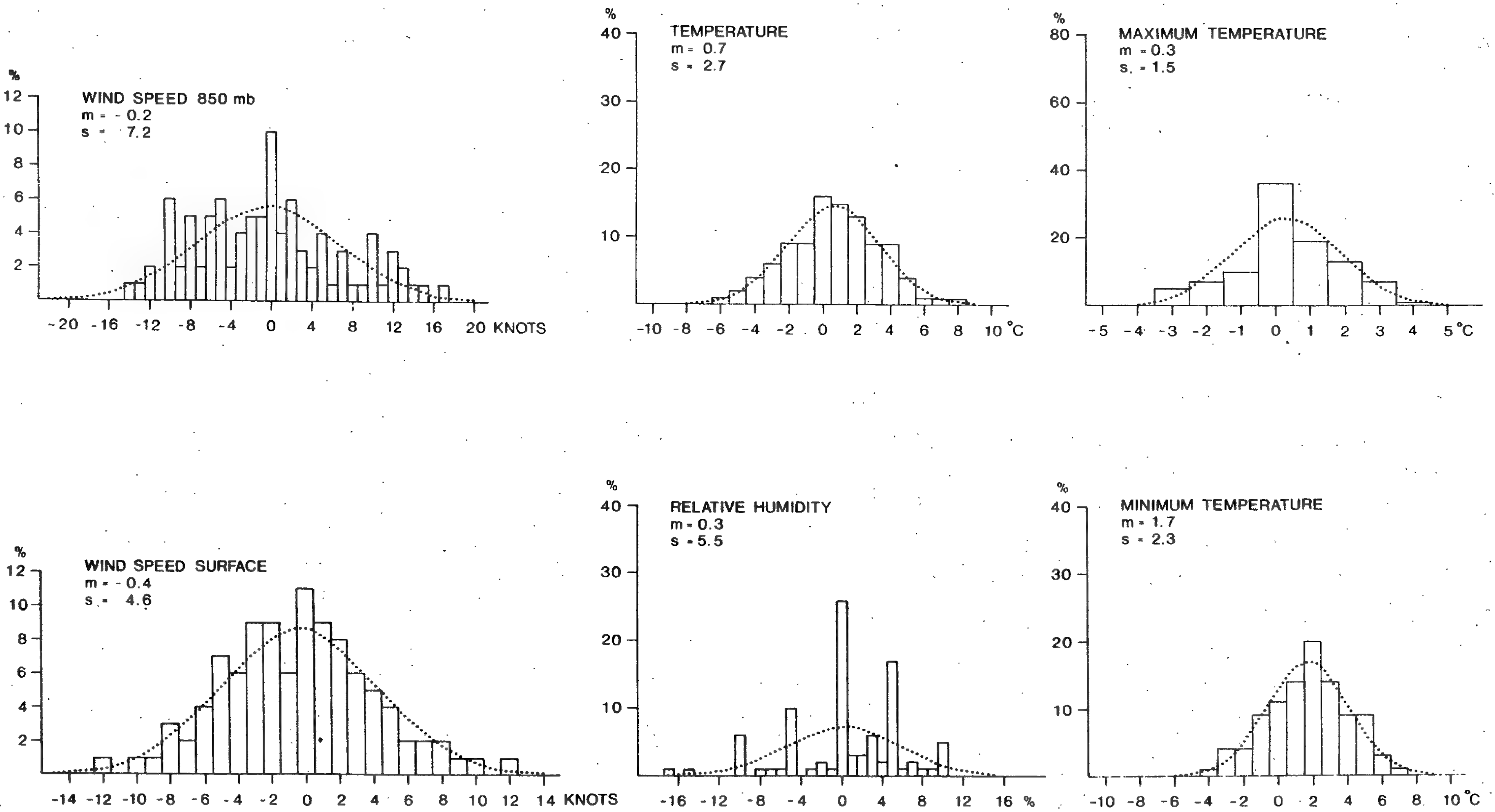
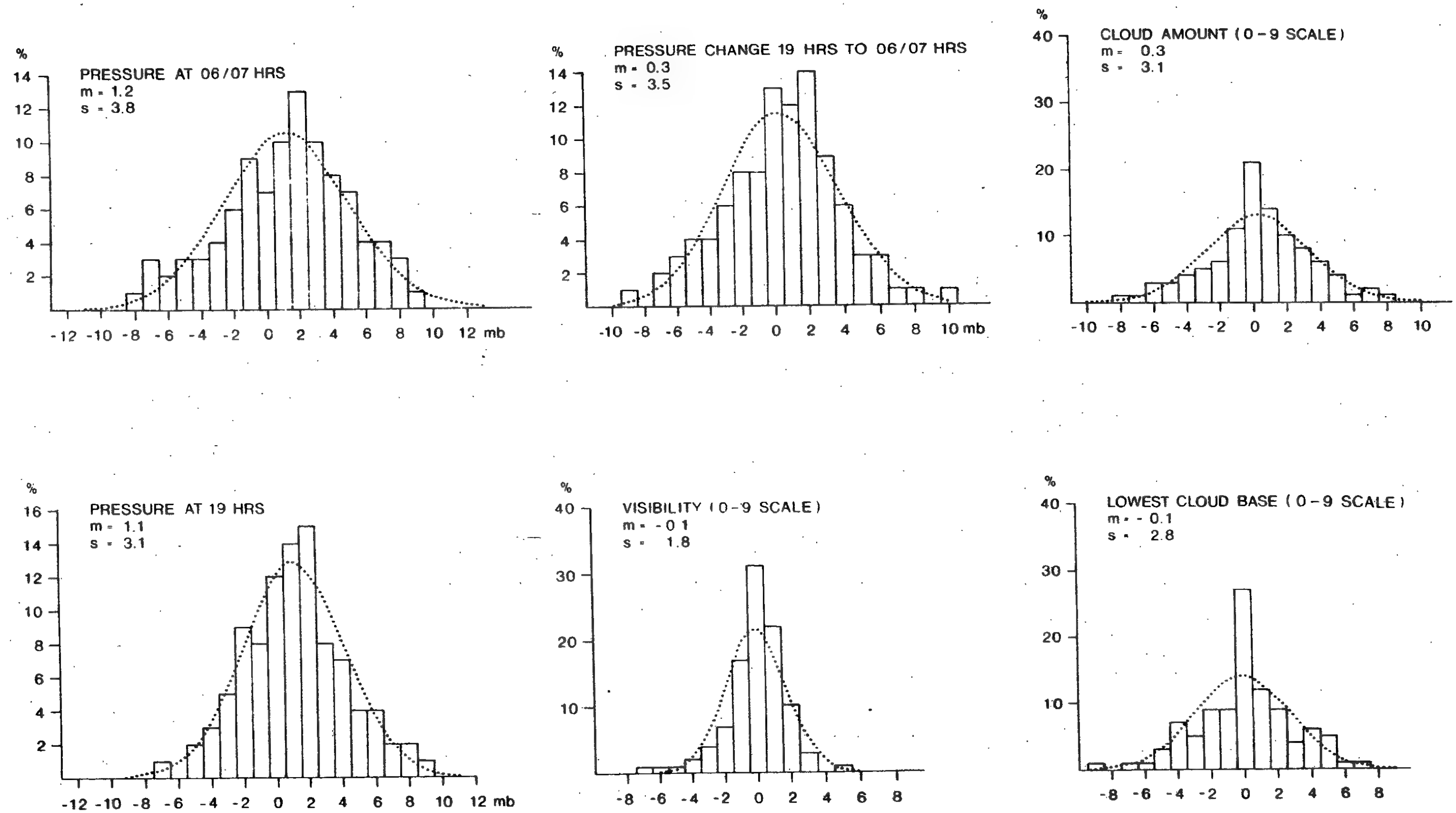

WIND DIRECTION 850 mb
COS W-WIND 850 mb
m = -0.01
s = 0.34
COS N-WIND 850 mb
m = 0.03
s = 0.35
WIND DIRECTION SURFACE
COS W-WIND SURFACE
m = 0.00
s = 0.50
COS N-WIND SURFACE
m = 0.04
s = 0.57
%

Fig. 6a



WIND SPEED 850 mb
m = - 0.2
s = 7.2
%
KNOTS
TEMPERATURE
m = 0.7
s = 2.7
°C
MAXIMUM TEMPERATURE
m = 0.3
s. = 1.5
WIND SPEED SURFACE
m = - 0.4
s = 4.6
RELATIVE HUMIDITY
m = 0.3
s = 5.5
MINIMUM TEMPERATURE
m = 1.7
s = 2.3

Fig. 6 b



PRESSURE AT 06/07 HRS
m = 1.2
s = 3.8
PRESSURE CHANGE 19 HRS TO 06/07 HRS
m = 0.3
s = 3.5
CLOUD AMOUNT (0 – 9 SCALE)
m = 0.3
s = 3.1
PRESSURE AT 19 HRS
m = 1.1
s = 3.1
VISIBILITY (0 – 9 SCALE)
m = -0.1
s = 1.8
LOWEST CLOUD BASE (0 – 9 SCALE)
m = -0.1
s = 2.8
%
mb

Fig. 6 c

PRESENT WEATHER

PREL \ FINAL	0	1	2
0	78	0	6
1	5	0	0
2	7	0	3

PAST WEATHER

PREL \ FINAL	0	1	2
0	57	4	6
1	11	4	3
2	5	2	7

0 NO PRECIPITATION
1 SHOWERS
2 RAIN, DRIZZLE

CONVECTIVE CLOUDS

PREL \ FINAL	0	1
0	43	15
1	19	23

0 NO CONVECTIVE CLOUDS
1 CONVECTIVE CLOUDS

Fig. 6 d

```
        DAY NO   1   5    10    15    20    25    30    35    40    45    50    55    60    65
                 .   .    .     .     .     .     .     .     .     .     .     .     .     .
        SEA      0+++-00+ +000 -  +++ + --0-0 -00+ +-0000    0++-+00+000+ + --  -
1977    LIGHT    -000- 00000000000+00 00 0+++-0-00++0000 0000-0 +0+-0+00-0  00 0-
        HEAVY              000-000000 0 000000000   00-0 -00000+0000000---0 +0 00+
                 .   .    .     .     .     .     .     .     .     .     .     .     .     .

                 0=WARNING CORRECT    +=WARNING UNNECESSARY    -=WARNING MISSED
```

	SEA	LIGHT	HEAVY
WARNING NECESSARY %	48	72	68
WARNING ISSUED %	57	74	63
FORECAST CORRECT %	57	74	86
WARNING UNNECESSARY %	26	14	5
WARNING MISSED %	17	12	9

```
        DAY NO   1   5    10    15    20    25    30    35    40    45    50    55    60    65    70
                 .   .    .     .     .     .     .     .     .     .     .     .     .     .     .
        SEA      0++++0+++ 0     ++- +++ -  -0-000-00++     +00+00000000+    --0 -
1978    LIGHT    00-0000-0 00000+0-0++000++0000000000000--0++0 00-+0+ 00-+0-  0------
        HEAVY          +0 0-00+ 0-0-+00-0+00+ 00000000 0000 00-00 000-0--000  -     -
                 .   .    .     .     .     .     .     .     .     .     .     .     .     .     .

                 0=WARNING CORRECT    +=WARNING UNNECESSARY    -=WARNING MISSED
```

	SEA	LIGHT	HEAVY
WARNING NECESSARY %	40	76	63
WARNING ISSUED %	53	70	56
FORECAST CORRECT %	64	66	79
WARNING UNNECESSARY %	24	14	7
WARNING MISSED %	11	20	14

MEAN 1977+1978

	SEA	LIGHT	HEAVY
WARNING NECESSARY %	44	74	65
WARNING ISSUED %	55	72	59
FORECAST CORRECT %	61	70	82
WARNING UNNECESSARY %	25	14	6
WARNING MISSED %	14	16	12

Fig. 7

ADF 616 083

BSCE 14 WP 5

What is BSCE?
How does it work?
Is there a need for a "Code of Practice of BSCE" or any equivalent document?

Lars-Olof Turesson, Sweden.

Abstract

The desirability of some type of document to describe the activities of BSCE has been discussed during the last years. It has not, however, been possible to formulate the total purpose of such a document nor to decide about the content or size of it. Different opinions have favourized either a comprehensive work going more into details of the practical work in the field than the ICAO "Airport Services Manual Bird Control and Reduction", or just a rather short description of the Committee and its work including the activities of the six working groups. - Contributions to a document of the more reduced type under a title "Code of Practice of BSCE" have upon request of me and the former chairman of BSCE been delivered by some of the working group chairmen.

According to my mind these two types of documents are both of value for our work especially for the co-operation with other internationel organizations. The big one will certainly help civil aviation authorities in many countries also within the sphere of interest of BSCE, bringing the work in the different countries in better conformity and making a better use of earlier experiences possible. The smaller document will have its value mainly for the contacts between BSCE and the international organizations involved into civil aviation (ICAO, ECAC, WEAA, IATA, IFALPA, IFATCA etc). With such a paper in the hand they will have the possibility to get a better understanding of our work in a brief and hopefully very readable way.

My intention is to present a draft to a short document at the plenary meeting of BSCE 14. The more comprehensive work is in fact now under way in most of our working groups through their compilations of procedures, preparations of booklets etc.

I hope that a discussion during our next meeting will help to solve the above mentioned informatory problem, also giving us proposals for adequate titles of the documents.

1. General outline of purpose with a special document and of the work of BSCE.

1.1 The purpose of a document type "Code of Practice" and/or some other documentation of the work of BSCE.

It has been considered valuable to prepare som type of rather short going through of the way of work of BSCE which might be called Code of Practice. In that way and through the distribution of such a document the activities of the Committee could be better known among all interested parties in the air safety work. A special wish on this matter has been expressed by the European Civil Aviation Conference (ECAC). Certainly also International Civil Aviation Organization (ICAO) has a considerable interest in a short account of the type of work which has now been going on for about 13 years time inside BSCE and its working groups.

A special purpose with this document is, that it can be useful for the development of international work on the bird problems in other regions of the world. For many member states of ICAO international co-operation about these affairs is a condition for successful work. One of the aims is here to help other ICAO-regions with the formation of Bird strike committees or other types of regional bodies for the bird problems of aviation. The first step on this way was taken in 1978 with the holding of a workshop on bird hazards for the Far East & Pacific region of ICAO. This event took place in Bangkok and BSCE assisted both with the planning and the realizing. It is possible that similar workshops will be organized in other ICAO regions during the early nineteen eighties.

For a more comprehensive description of the methods of work with the bird problems of aviation a study of the ICAO document Airport Manual part III, can be recommended. BSCE has given its contribution to the second edition of this document issued in the autumn of 1978.

Work is now also under way in most of the BSCE working groups with compilations of procedures, preparations of booklets etc for a detailed documentation of the activities of resp groups and for an exhaustive description of what is or can be done in the field within the sphere of interest of each group. The material from the working groups will then have to be put together to one document which will form a handbook for all BSCE work with the bird problems of aviation.

The aim of this future main document of BSCE will be to supplement the ICAO manual concerning the Europe and Mediterranean region which we feel a special responsibility for. This can be done by going more in details with explanations of both proven technics and experimental ones. By doing so we hope that the work in the field will be made easier and that many questions

of how to get on with certain problems can be avoided. - We in BSCE have the feeling that the big task with the preparing of this document is worthwhile because Europe is a rather homogeneous area for bird as well as for aircraft movements and because technics used in airports are in general comparable from one country to another.

1.2 Short history

A purposeful work with the problems for aviation caused by birds started up in the early nineteen sixties. Introduction of fast, turboengined airplanes had highlighted the increased danger of men and birds sharing the same airspace. Some pioneers arranged 1963 a symposium in Nice for discussions and lectures concerning this new section of air safety work. The results of the symposium were promising so three years later it was decided to begin a continous, international activity which took the form of the establishment of an organization called Bird Strike Committe Europe The committe held its first meeting 1966 in Frankfurt and thereafter yearly meetings have been arranged until the end of the nineteen seventies, but from now on there is 1,5 years between two consecutive meetings. During the first years only a few West-European states, USA and Canada took part in the BSCE-meetings but in the nineteen seventies the participation has broadened so that 13 states from all parts of Europe sent delegates to the 13th meeting in Berne 1978. Observers from three international organizations did also attend that conference. Of countries outside Europe has also Israel beside Canada and USA become involved in the activities of BSCE. Canada was in fact asked to help BSCE during its first years of activity as that state was a pioneer in tackling the bird problems of aviation and therefore had gathered a comprehensive experience.

For some years the Committee had relations to NATO which organization had started work already in the early nineteen sixties in order to reduce the number of collisions. Some civil experts worked partly for NATO with the bird problems of aviation and also belonged to the group of founders of BSCE. The mutual interest in this section of aviation safety work was promoted by NATO through giving economical contributions for research purposes to one of the BSCE working groups (Bird/Radar/Weather). During the first half part of the nineteen seventies, however, this co-operation gradually finished.

The main achievements of BSCE has been reached by its working groups. The establishment of these groups shows the order in which specific problems came up to discussion and had to be solved.

At the beginning it was found very essential to set up some type of observation and warning network and therefore working groups Radar and Transmission were founded. The former group concentrated on the task how to follow bird movements, specially migratory ones, by the aid of radar, whereas the latter had to develop a system for distribution of warnings for high bird intensity.

With experience gained during the first years of work BSCE entered the stage of research and development by forming another two working groups: Bird movement and Bird/Radar/Weather. The members of the Committee in different states prepared, often by the aid of newly founded national committees, maps showing birds main migratory routes and concentration areas. The earlier mentioned Bird/Radar/Weather working group, sponsored by Nato, carried out important studies on the relationship between weather and bird movements also with a considerable help of Canadian authorities for aviation and for wildlife preservation. - It must here also be emphasized that for many years time the strings between BSCE and the Canadian "Associate Committee on Bird Hazards to Aircraft" were of utmost importance for our work.

Pure operational problems had to some extent been taken care of by BSCE itself or by members of its Editing Committee which was formed at a rather early stage, but 1972 working groups were established for Analysis and for Aerodromes. The former group has to analyse bird strike statistics in the best possible way and the latter has to give advise on how to manage the work in the airport in order to reduce the number of bird/aircraft collisions there.

Finally a working group for Structural Testing of Airframes started its work in 1976. The aim of this group is to collect and analyse results of any bird impact structural testing and also to keep informed of any future testing programme.

Over the years there has also been some changes of the activities carried out by the BSCE working groups. Here can be mentioned that the WG Bird/Radar/Weather terminated its work in 1974 and that the WG Transmissions was 1977 transformed to a group for Communications and Flight Procedures with considerably widened tasks.

As BSCE has no funds and therefore not the same type of firm administration as the big international organizations dealing with aviation, the work of the chairman and the earlier mentioned Editing Committee has become the main uniting force. The Editing Committee, where all working group chairmen are members, is according to its term of reference "a policy steering committee to assist the chairman of the BSCE between and during meetings" (the full term of reference will be included into para 1.3 of this document). In 1976 a vice chairman of BSCE was elected but the post is now vacant. In order to reduce the workload of the chairman a new post as "liaison officer" was created in 1978 with the aim to take care of the relations with other international bodies.

During the first years of its existance BSCE had rather little contact with ICAO but in the early nineteen seventies some co-operation started up and in 1975 an agreement was reached that the relationship between the two international bodies should be expressed in the following terms:

"The BSCE acts in an advisory capacity to ICAO, working through the European office of ICAO, on matters concerning the hazard to aviation caused by birds."

The co-operational work between BSCE and ICAO has since the middle of the nineteen seventies functioned in the above mentioned way. The ties with the big aviation organization has strengthened considerably not only with the European office but also with the headquarters in Montreal. An important role has in this respect played the ICAO activities with regional workshops on bird hazards which started last year and which is likely to continue in the early nineteen eighties (see 1.1).

Some co-operation has started also with ECAC which, as mentioned above, has asked BSCE for this type of document. ECAC was also represented at the Third World Conference on Bird Hazards to Aircraft and they have declared their willingness to give help with important BSCE activities on bird hazards which are in the sphere of interest of ECAC. The former chairman and acting liaison officer of BSCE is an observer at the meetings of the ECAC Technical Committee, a fact which facilitates the co-operation between the two European organizations.

The International Air Transport Association (IATA) has during the last few years showed an increasing interest in the bird problems of aviation. A main reason for this is the evidently increasing costs caused by severe collisions between aircraft and birds. It might be mentioned that IATA had several representatives in the earlier mentioned workshop in Bangkok and that they have promised to help with the implementation of an improved distribution of bird strike reports proposed by BSCE and recommended by ICAO.

BSCE has also ties with IFALPA partly depending in the fact that some active BSCE-members are pilots and involved in IFALPA activities too. Another international body of interest for BSCE is IFATCA which had an observer at our meeting in Berne 1978 and which has received a special invitation to attend and present a paper at BSCE 14.

A more comprehensive history of the work of BSCE, specially concerning the annual meetings, is given in another paper to BSCE 14: "The first ten years of BSCE" by Vital Ferry. You will there find a list of all lectures given during the period 1966-1975, in all more than 100 papers.

1.3 Methods of work

1.3.1 Terms of Reference of BSCE

The first Terms of Reference of BSCE were defined already at the second meeting of the Committee in the Hague, 1967. After that the document has been changed a few times in order to reflect as well as possible the purpose and the activities of BSCE. The edition of it that is now valid reads as follows:

The Bird Strike Committee Europe shall

a) collect, analyse and circulate to all concerned data and information related to the bird strike problem in the European Region;

Note: This data and information should include the following:

1. Civil and/or military data collections and results of analyses on bird strikes to aircraft.

2. Results of any studies or examinations undertaken by States in the various fields related to the bird problem.

3. Any information available in the field of design and structural testing of airframes related to their resistance to birdstrikes.

4. Any other information having a bearing on the bird strike question and the adding to the solution of the various problems involved.

b) study and develop methods to control the presence of birds on and near aerodromes;

c) investigate electro-magnetic wave sensing methods (e.g.: radar, invisible light, etc) for observing bird movements;

d) develop procedures for the timely warning of pilots concerned where the existance of a bird hazard has positively been established;

e) develop procedures, if appropriate, for the initiation by air traffic control of avoiding action where the existance of a bird hazard has positively been established;

f) develop procedures enabling a quick and reliable exchange of messages regarding bird hazard warnings;

g) develop any material (e.g.: maps, back-ground information, etc) intended for inclusion in Aeronautical Information Publications;

h) aim at a uniform application, throughout the European Region, of the methods and procedures and the use of material developed in accordance with b) to g) above, provided suitable trials have proved their feasibility, and monitor developments in this respect.

1.3.2 Functions of the chairman and vice chairman

An outline of the different media and of the ways of working of BSCE is given in appendix 1. It is evident from that scetch and from what is earlier mentioned in para 1.2 that the main point of the work of BSCE is laid on the chairman, vice chairman and from recently also the liaison officer as well as to some extent

the Editing Committee. Even if BSCE has no real secretariat, all functions of the Committee beeing carried out by people working only part time with the bird problems of aviation, there is quite an important workload mainly consisting of correspondence. Studying the register of letters from July 1978 to July 1979 written by the chairman, the total number comes up to 115. Of these were 22 letters to the liaison officer and 35 to the Editing Committee and members of it. A considerable part of this correspondence deals with preparational work before future meetings and also to a minor part conluding work after meetings. Many other tasks are, however, going on between meetings dealing with our international contacts, for instance the co-operation with ICAO. 33 letters were sent to representatives for national committees in different countries with content of very various art. Finally the direct contact with international organizations and governmental authorities in many countries have resulted in 25 letters. The chairman is also responsible for smaller meetings with members of the Editing Committee or part of it which may have to be held in the periods between the main meetings of BSCE. Such a small meeting was held in Copenhagen on 10 May this year for the reason of preparational work before BSCE 14 but many other subjects were also on the agenda.

1.3.3 Aim with and tasks for the liaison officer

The new function as liaison officer which was at BSCE 13 entrusted to the resigning chairman has the aim to facilitate and improve the co-operation with other international bodies. The chairman's report from the meeting in Berne reads in this respect: "The liaison officer was specially charged to visit all relevant authorities at a convenient level, to obtain better liaison and understanding." There is also a special intention of BSCE that the creation of this post will facilitate the work of the chairman and reduce his workload. Among important tasks that has been dealt with during the last year can be mentioned the EEC Council Directive on bird conservation and the idea to start direct co-operation with the international ornithology by trying to hold a symposium with world wide participation on birds behaviour to aviation together with the 18:th International Ornithological Congress.

1.3.4 Way of work of the Editing Committee

The main functions of the BSCE Editing Committee have over the years been to evaluate the working papers to be presented at the ordinary meetings and to participate in the preparation of recommendations and of other text to be included in the Report of resp meeting. In the periods between meetings there has been, as is earlier mentioned, a considerable correspondence between the chairman, vice chairman and liaison officer on one hand and the other members of the Editing Committee on the other hand. A few smaller meetings have also taken place for preparational work and to some extent also for the practice of the committee function as a policy steering body. The total purpose of and tasks for the Editing Committee is given in its "Terms of Reference" which is attached to this document as appendix 2.

1.3.5 BSCE meetings

From the start of BSCE in 1966 and until 1978 the Committee had annual meetings which means that the Hague meeting last year was the 13th. One of the decisions there was that the period between two consecutive meetings should be expanded to 1.5 years. As a main reason for this decision was said that the Committee had "passed its earliest era and that in a later phase of activity the demands for frequent conferences must be looked upon as less weighty."

The ordinary meetings of BSCE including its working groups have been the main forum for new ideas about how to tackle the bird problems of aviation in Europe. That has been done principally through presentation of papers dealing with all sections of this flight safety work but also by decisions made at the plenary sessions giving recommendations on how to work with the bird problems. The number of working papers has from a modest beginning been increased to about 30 during the last meetings. More details about this important part of the work is given in the earlier mentioned working paper No 1 to BSCE 14.

When it comes to recommendations and conclusions from the meetings can be mentioned as an important example the very first one from the first Committee meeting which was held in Frankfurt/Main in 20-21 July 1966 (in fact the name Bird Strike Committee Europe did not show up until the 4th meeting in 1969). That conclusion reads:

"The methods and possibilities for scaring birds off the airbases developed and practised by member countries should be regarded as a guidance for the respective measures to be taken by the other national Committees for Flight Safety".
Another conclusion of general nature is the first one from the second meeting of the Committee:

"Planning of new airfields should be undertaken in close co-operation with national bird strike working groups." -That sentence is really still valid!

The recommendations from the last meetings go more in details and refer to the activities of the different working groups. As an example of the BSCE work of to-day might be mentioned those recommendations which were issued as results of the work at BSCE 13 and which are attached to this document as appendix 3.

The participation at the BSCE meetings has increased and broadened considerably over the years. At the first meetings there were mainly militaries and ornithologists present to a number of 20-25 whereas during the last meetings we have had 60-80 participants (more at BSCE 12 which was held in association with the third world wide meeting) belonging to a great variety of professions (see app 1).

1.3.6 The functioning of the BSCE working groups

Already in para 1.1 and 1.2 has been mentioned shortly about the significance of the work of the BSCE working groups which forms altogether a very considerable part of the total activities of the Committee.

Naturally the most important part of the activities of the six working groups are carried out in connection with the ordinary meetings of BSCE. Each W.G. has a chairman and a vice chairman who have as their tasks to prepare, carry through and do the supplementary work of the W.G. meetings.

These include normally a handling of recommendations from the previous meeting, presentations of papers which are of an interest limited to the field of activities of that working group, discussions after the lectures which may lead to new recommendations, handling of proposals possibly also leading to recommendations, etc. An example of the work of a BSCE working group with a lot of activities going on is given in the report of W.G. Aerodrome at BSCE 13 which is attached here as appendix 4.

There is certainly also some activeness going on inside the working groups during the long periods between the BSCE meetings. Preparations of questionnaires and analysis of results from them, compiling of experiences in the form of brochures and booklets, etc, are examples of that type of work. Almost the entirety of that work has to be managed by correspondence but a few times special working group meetings have taken place.

The intention with this section of the document is just to give information on how the WG:s are functioning whereas the description of the content of the work is given in chapter 2.

2. Description of the sphere of activities of the BSCE working groups.

2.1 Analysis working group

2.1.1 Formation and purpose of the group.

The Analysis working group was formed at the 7th meeting of BSCE in London, June 1972. It was felt that knowledge of the statistics of birdstrikes and an improved analysis of them were necessary for the combatting of the problem from all possible sides.

2.1.2 Initial objectives and methods of working

The more detailed reasons for the formation of the working group and its initial tasks were the following:

2.1.2.1 A great number of different report forms were used all over Europe and some countries had two or more forms in use. As this situation was found very unsatisfactory it was decided, that members of this group had to work for the establishment of uniform conditions in a way that the ICAO report forms (or national equivalents) should be used for the reporting of strikes.

In 1978 a review of the present report form was initiated by ICAO. The study included distribution of a questionnaire to all memberstates. So far (July 1979) no results from that review has become known.

2.1.2.2 Earlier statistics of birdstrikes had in a few countries showed lacks for the reason that more than one authority was responsible for the collection of bird strike reports. At the start of the group it was found necessary to work for a state of things where only one person or one authority in each country should be responsible for the collection of reports.

2.1.2.3 The analysis of bird strikes had up to now been unsatisfying or even non-existent in some states.

Civil and military authorities had also often been analysing in different ways. A very important task for the group was therefore to develop a standardized format for the analysis of strikes valid for both civil and military purpose.

2.1.2.4 Once a standardized format was developped each country would analyse all birdstrikes using that format. A special BSCE-format was worked out in order to solve the problems.

2.1.2.5 Each country has now to send the chairman of the working group its national analysis using the BSCE-format. With this procedure it is possible to compare in a meaningful way data (also including military ones) from different countries.

2.1.2.6 With the aid of analysis from all membercountries it is the duty for the chairman of the group to form a large sample in order to produce an annual paper "Bird strikes during..... (relevant year) to European aircraft.

2.1.2.7 From time to time special investigations are made using the European data.

2.1.2.8 A periodic Bulletin of Serious Bird Strike Incidents is circulated by the Chairman.

2.1.3 BSCE standardized analysis format (for aircraft with a weight over 5 700 kg).

The following areas of investigation are covered:

Aircraft Type	(using movements to give rates)
Aerodrome	(" " " " ")
Bird Species	
Month of Year	(divided into bird weight categories)
Time of Day	(" " " " ")
Airspeed	(" " " " ")
Altitude	(" " " " ")
Flight Stage	(" " " " ")
Part of Aircraft Struck	(" " " " ")
Effect of Strike	(" " " " ")
Cost	(" " " " ")
Aircraft Operator reporting	(using movements to give rates)
Weather	(divided into Day, Night, Dawn, Dusk)
Use of lights	

2.1.4 Data according to the BSCE format about strikes to civil aircraft is supplied by the following countries:

Belgium
Denmark
Finland
France
Netherlands
Norway
Sweden
Switzerland
United Kingdom

2.1.5 The following papers have been prepared by the aid of data from the BSCE analysis:

Bird Strikes to European Registered Civil Aircraft 1972, 1973, 1974, 1975, 1976 and 1977

Bird Strikes to European Registered Civil Aircraft 1972-1975 (compilation).

Bird Strikes to Transport Aircraft Jet Engines.

The use of Landing Lights in Reducing Bird Strikes.

Bird Strikes to Military Aircraft 1977.

2.1.6 A number of conclusions have been reached by examination of the annual reports as follows:

(a) There is considerable variation in reported rate from country to country and year to year.

(b) There does not appear to be much correlation between strike rate and aeroplane type. However, the wide-bodied aircraft as a group do show an above average rate.

(c) The gull is the species most frequently struck. Very few birds of weight greater than 1.8 kg (4lb) are struck.

(d) The greatest strike rate is in October.

(e) A number of major airports have markedly above average strike rates.

(f) Approx 17% of strikes occurred at nights when aircraft movements are very infrequent.

(g) As 95% of strikes occurred at aircraft speeds above 80 knots it appears that up to that speed birds can successfully avoid aircraft (the low number of strikes to light aircraft and helicopters tends to support this).

(h) Only 15% of strikes occur above 200 ft altitude.

(i) The final approach and landing accounted for the same percentage of strikes as the take-off.

(j) The nose section and radome were struck in 32% of incidents, whilst engines accounted for 19%. There have been over 20 incidents where more than one engine was struck.

(k) The major effects on the aeroplane are that one in five strikes to the engine necessitates engine change/repair, a total of 141 engines in all during the four year period. In addition one in five radome strikes necessitates a new radome.

(l) the cost to European airlines of bird strikes is over 2 mil million US dollars per annum.

2.1.7 Some trends have been noted about engines

(a) Wing mounted engines are more likely to suffer bird strikes than aft mounted engines by a significant factor.

(b) Some engine designs have considerably less resistance to bird strikes than others.

2.1.8 Work is in progress to set up a computer data base for storage and analysis of bird strike data on civil aircraft. The system is planned to become operational 1980 and will then be used for the analysis of bird strikes 1979.

3.1 Radar working group

3.1.1 Formation and purpose of the group

The Radar working group was formed at the 6th meeting of BSCE in Copenhagen, June 1971. The aim of the group has been to advise BSCE on radar matters to enable countries to exchange information in radar techniques and the operational use of radar for studies of bird movements.

3.1.2 Terms of reference

The Radar working group is a technical sub-committee of BSCE dealing with matters associated with use of radar in the surveillance, the identification and the assessment of bird movements. The group is composed of engineers, air traffic controllers and research scientists currently using radar on bird strike and allied problems. The work of the group embraces the evaluation of the radar properties of birds, of specific radar equipments and techniques, of improvements in design and data handling and also of best ways of operating radars.

3.1.3 Methods of working

3.1.3.1 It has been made clear from a long time before the formation of BSCE that radar can be used for detection of bird movements. However, studies within the framework of the BSCE Radar working group have increased our knowledge in this field very much and there is a feeling that the potential is high for even more valuable studies in the future. The only risk for a limitation of the possibilities associated with the use of radar seems to be the fact that the number of radarstations suitable for bird studies (those with raw radar data) is going to be gradually reduced due to the fact that ATC systems are more and more relying on Secondary Surveillance Radars.

3.1.3.2 Research and operational studies of bird movements with the aid of radar has over the years been carried out in three different ways:

a) Direct observations of the PPI and to some extent RHI.

b) Photographing, mainly by polaroid camera.

c) Filming.

A long raw of working papers to the BSCE conferences have demonstrated the usefulness of these methods especially b) and c).
- Studies have been focused in time on either migration periods or non seasonal movements.

3.1.3.3 Radarstudies of bird movements have made possible the acquisition of data from the following parameters:

a) Direction of movement.

d) Speed.

c) Altitude.

d) Density of birds.

For all these parameters radar has prooved to be a very good instrument superior to visual observations. As a result of this, pure ornithological research has also benefitted of studies with the main purpose of reducing bird strike risks.

3.1.3.4 Intensity scale

A scale of radar plan position indicator (PPI) bird echo intensities for warning of bird migration was adopted by BSCE at an early stage of its work. The scale was prepared after studies of filmed still photographs with long time of exposure. As a result of this work an 8-point PPI echo intensity scale was specified as follows:

Intensity	Risk of bird strikes
0	Practically NIL
1	Extremely small
2	Very small
3	Small
4	Fairly small
5	Fairly great
6	Great
7	Very great
8	Extremely great

Observations of bird movements by radar have over the years been used for warnings in form of BIRDTAMs when high intensity according to the above mentioned scale has been observed. During the last years automatic and semiautomatic counting systems have been taken into use in a few countries. Discussions on these problems have occured at most of the BSCE conferences and numerous papers relating to the matter have been presented. Here can specially be mentioned a working paper for the ICAO Workshop on reducing bird hazards held in Bangkok, March 1978. which had the title "Possible use of radar for prevention of bird/aircraft collisions". - In order to improve international co-operation in the field of bird migration studies it has been recommended that "France, Germany and Switzerland co-ordinate their observations of bird concentrations along the Alpin ranges to establish the length and breadth of this migratory movements which may constitute a collision hazard".

3.1.4 New ideas and future possibilities

The radar working group is for the moment (autumn 1979) considering the possibilities of the use in future of some other types of instruments for bird observations. These equipments are the following:

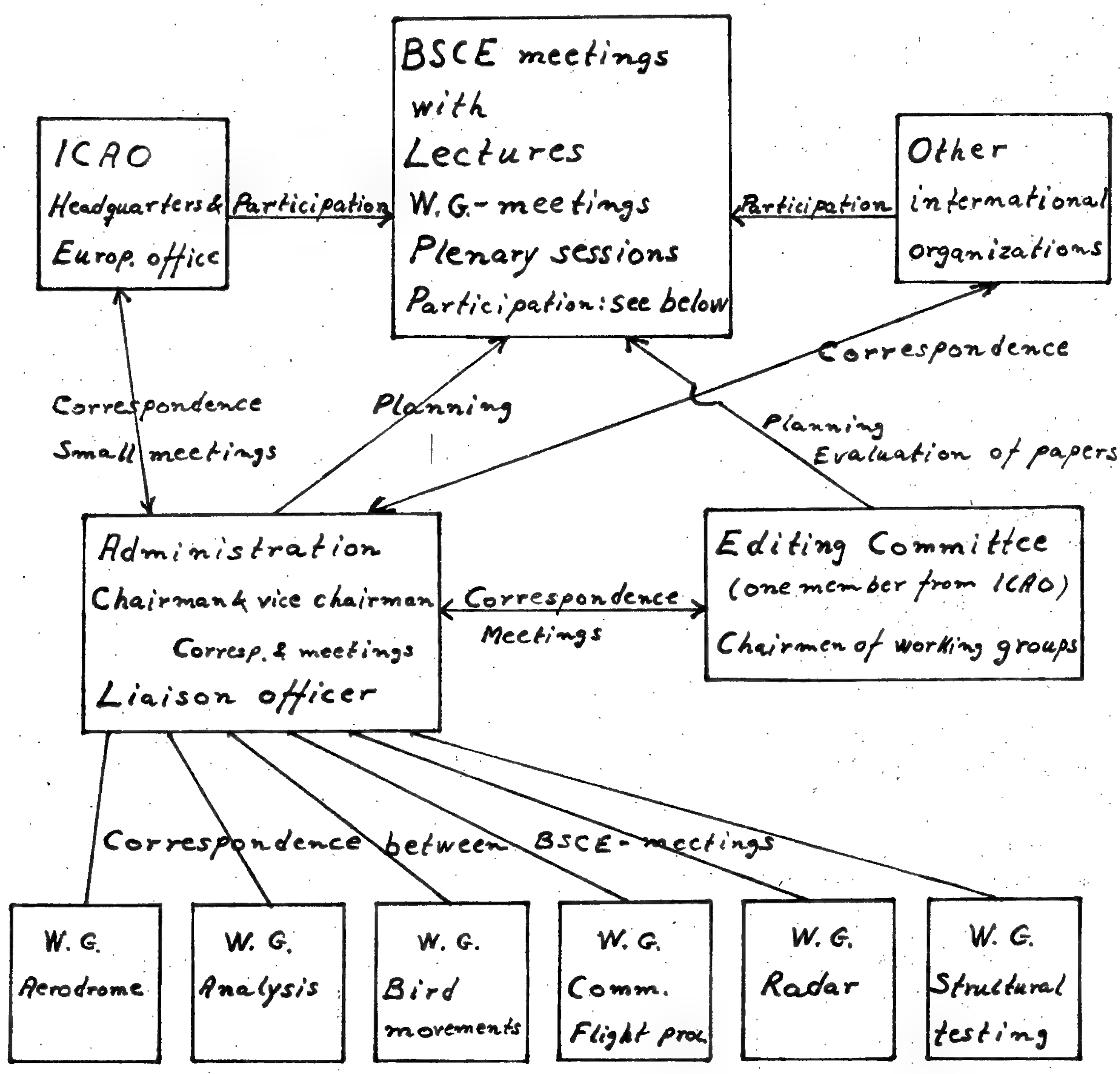
a) Sodar (Sound Detection and Ranging) or acoustical sounding equipment.

b) Image-intensification equipment.

c) Infrared viewing equipment.

Appendix 1

Ways of working of Bird Strike Committee Europe.



Participants at meetings

Representatives for:

Authorities for civil and military aviation

Organizations for aviation research

Airlines. Pilots and their organizations. Flight insurance comp.

Zoological, environmental, agricultural and meteorological institutions.

Appendix 2

TERMS OF REFERENCE OF THE EDITING COMMITTEE, BSCE

1. An Editing Committee is appointed as a policy steering committee to assist the Chairman of the BSCE between and during Meetings. The main tasks of the Editing Committee are :

   a) study, evaluate and select papers to be presented to the Working Group and the Plenary Meeting,

   b) during each BSCE Meeting participate in preparing recommendations, proposals for text for inclusion in the Report, and, where necessary, any other papers of a general nature.

   c) at the end of each BSCE Meeting participate in preparing the Report of the meeting and prepare the follow-up action of recommendations.

   d) assist the BSCE Chairman in formulating BSCE Policy Statements.

2. The Editing Committee should consist of :

   (i) The BSCE Chairman and Vice Chairman

   (ii) The previous BSCE Chairman, if possible

   (iii) The Chairman of each BSCE Working Group

   (iv) The observer from ICAO

   (v) A representative of the host State.

3. The BSCE Chairman acts also as the chairman of this committee and is entitled to call meetings of the Editing Committee as and when required during BSCE Meetings.

4. The conclusions of the Editing Committee should be presented to the Plenary Meeting of the BSCE for action. Alternatively the members of the BSCE should be kept informed of the activity of the Editing Committee between full meetings of the BSCE.

THE BIRD STRIKE COMMITTEE EUROPE RECOMMENDATIONS

A. Based on the work of Bird Movement working group

1. Countries are requested to rewise continously the existing combined bird strike risk maps (scale 1:2000000) and the AIP-maps regarding special criteria.

2. Countries should use wings as special symbols for bird concentration areas in the ICAO aeronautical maps (similar to that shown at the Danish maps).

B. Based on the work of Analysis working group

1. Each airline should be encouraged to make bird strike reporting forms available in the cockpit of every aircraft.

2. In accordance with ICAO State letter AN3/32-76/111 "Foreign" bird strikes should be made known to the country in which they occur. In the Far East Asia/Pacific Region these should be sent via the ICAO Regional Office in Bangkok, who have agreed to act as coordinators.

C. Based on the work of Radar working group

1. The committee confirms recommendation C1/BSCE 12 and emphasizes the need to improve the active collaboration in bird migration research in Europe. The Committee also recommends that in addition to the radar chain along the Alps, a second chain should be established throughout the North Sea area, if technically possible.

D. Based on the work of Structural testing of Airframes working group

1. That, to facilitate a more positive and orderly response by BSCE participating countries to the tasks of the Working Group, a member should be appointed by the national committee for bird strikes of each participating country to be responsible for reporting to the BSCE progress in support of the recommended tasks of the Working Group.

2. That the attention of pilots and operators should be continued to be drawn to the deterioration in bird impact resistance of windscreens which rely on the maintenance of an optimum temperature for strength if,

   - insufficient time is given for warming up the windscreen before take-off, or

   - the temperature is too high because the aircraft has been parked in the sun.

E. Based on the work of Aerodrome working group

1. There is a need for properly conducted scientific experiments, which can decide if chemical agents repel birds on airports.

2. A brochure with the aim to contain all procedures to reduce bird hazards at aerodromes is in preparation by the group. The document shall be made available to all interested parties and sent to all different international organisations concerned.

F. <u>Based on the work of Communications and Flight Procedures working group</u>

1. That, in support of recommendation made during 12th meeting the group should be reactivated.

2. That an experimental use of ATIS for transmission of bird movements information be started in countries and a summary of the experience gained in so doing be prepared by the group.

ACTIVITIES OF THE WORKING GROUP

1. Title : AERODROME

2. Recommendations from the 12th meeting (not reproduced here)

3. Progress report :

3.1 The names and addresses of the participants of the meeting are contained in attachement A to this paper.

3.2 The Chairman opened the meeting and informed about different practical details.

The Chairman of BSCE expressed the wish to thank the Vice Chairman for the substantial work done by producing the working papers 10 - 12.

3.3 The Working Group then reviewed the working papers presented to it.

3.3.1 Management on airport or in their vicinity.

WP 10a : Garbage dumps in the vicinity of Airports.
The paper was approved.

WP 10b : Homing pigeons in the vicinity of Airports.
The French delegation indicated that the text covering France was not reflecting the true situation. It was agreed that Mr. Ferry, within 14 days, will send a draft of a revised text to the Vice Chairman of the Working Group.
Mr. Lind and Mr. Thorpe informed the Meeting that the item was really covering two different issues, that of breeding pigeons and that of racing pigeons. The meeting agreed that this question should be studied again by correspondence indicating the problem and asking for clarification.

WP 10c : Use of land in the vicinity of Airports.
The paper was approved.

WP 11a : The length of the grass on Aerodromes.
The original title of the paper was "Length of the grass along the runways". The meeting suggested the title changed to the wording used above.
The paper was approved.

WP 33 : Practical and economical aspects of grassland management.
The paper informed about the experiences gained at the Dutch Leeuwarden Air force base. It had been experienced that the best solution was to mowe the grass several times during the year and to cut the grass rather short. This was due to a number of reasons such as :

- The very fertile soil and the humid oceanic climate.
- Local farmers needed the grass due to shortage of land.
- Certain military requirements.

Mr. Thorpe said that a British investigation had shown that the best solution was the "Long grass solution".

A representative of the Federal Republic of Germany reported that the German experience was that the optimum grass length would have to be decided upon according to the soil. The representative will provide the Vice Chairman with more detailed information in the very near future.

The Chairman noticed that the additional benefit obtained by a very intensive utilization of the area was about 50.000 Dutch guilders. This amount of money was very small compared to the amount of money involved in bird strikes.

The meeting concluded that though the "Long grass solution" was generally applicable, attention must always be paid to local conditions.

Mr. Buurma RNAF promised to supply information regarding the Dutch Air Force because the questionnaire had only been answered for Schiphol and only for some points.

WP 11b : Sanctuaries in the vicinity of Airports.
The paper was approved.

WP 11c : Trees and bushes in the vicinity of Airports.
Several members explained that there was a growing tendency to establish wood areas as a protection barrier against aircraft noise and smells from exhaust products. Such wood areas may increase the bird strike risk.

3.3.2 Chemical repellents.

WP 12a : Use of chemicals to make the soil of Airports'surroundings unattractive.
A Representative for the Federal Republic of Germany informed the meeting about the experiences gained during experiments. All experiments with chemicals were now abandoned in the interest of the environment. The representative mentioned will provide the Vice Chairman with details about these experiences.
The paper was approved.

WP 25 : A report from the Froebel Institute.
The author of the paper, Mr. Martyn Riley, presented the paper which reported about a chemical repellent called SAAS. This chemical agent had been used for the protection of fruit farms against birds. Though the results were preliminary, the paper was optimistic regarding the effect of SAAS. Mr. Riley informed that SAAS was identical with another chemical agent known as RETA.

./3

Several members expressed the view that the results of the paper were much more optimistic than the experiences gained through tests at different airports.

Mr. Thorpe informed about tests being carried out in UK. The results of these tests so far available were not likely to encourage the application of RETA.

WP 28 : Current trials of RETA bird repellent.
This paper reported about French experiments being carried out at Marseille-Marignane Airport.

The Aerodrome Working Group will collect the results from the British and the French experiments as well as the results of all other experiments which will become available.

After a long discussion on the subject "chemical bird repellent" the Aerodrome Working Group agreed on the recommendations set out below :

Recommendation to the BSCE :

1) There is as yet no scientific evidence that the application of chemical agents work as birds repellents on airports.

2) There is a need for properly conducted scientific monitored experiments, which can decide if chemical agents repel birds on airports.

3.3.3 Pyroacoustical devices.

WP 12b : Bird dispersal devices.
The prices indicated in the paper for equipment will be deleted. They will be replaced by an approximative minimum price.

It was decided, as a result of the discussions, that information should be collected regarding such subjects as :

Total expenses relating to bird strike preventive measures.
Manpower employed in relation to these measures.
Organization of the different tasks in relation to these measures.
(People working full-time or part-time with bird strike prevention).
Education of the personnel working on bird strike prevention.

WP 12c : Organization of the scaring away of the birds.

Use of Fixed Installations or Mobile Units.
Mr. Lind asked how it was possible to cover a 3-4000 meter runway by applying fixed installations. The French delegation explained that fixed installations were used in areas having a potential risk and did not cover the entire runway. The use of fixed installations were motivated by economic considerations.
The paper was approved.

./4

WP 27 : Measures available to the Airport Management for the reduction of the bird strike risk.
The paper was approved.

The meeting discussed what should be done with the information contained in working papers 10a - 12c incl. and 27. It was recommended that :

Recommendation No 3

The Chairman will draft the papers into one paper. This paper shall be made available to all interested parties and the BSCE Chairman is asked to send the paper to different international organizations.

3.3.4 Further improvement.

Information about names and addresses of the persons who have been responsible for answering the questionnaire will be included.

The question of blacklisting of airports having inadequate bird strike prevention measures was raised. No member of the Working Group could support such a procedure and several members warn against all the difficulties which such a procedure could lead to.

During the main meeting WP 31 was referred to for WG consideration. It was stated that an english translator will be available soon thus enabling the group to study it at the next meeting.

It was revealed during the discussions that, in order to be able to evaluate the effect of certain measures or to evaluate the situation at a given airport, it was necessary to have information about both the bird strike rate and the bird strike preventive measures used. The Meeting recommended that :

Recommendation No 4

The Chairman of BSCE is asked to contact the European Civil Aviation Conference (ECAC) and to ask for the assistance of this organization in collecting information about bird strike preventive measures applied at European airports.

3.3.5 If an agreement is reached with ECAC regarding this matter a draft questionnaire will be worked out by the Chairman of the Aerodrome Working Group.

AD F 616 084

WP 6A

US INITIATIVES IN BIRD HAZARD REDUCTION

This paper summarizes current initiatives in the United States regarding bird hazard reduction. Since our last participation with the Bird Strike Committee Europe (BSCE) at the 12th BSCE Meeting we have been active in developing a national program to reduce bird hazards on airports serving commercial air carriers. We have made significant progress in the reporting of bird strikes, airport bird control, research and development of a national organization to address the problem.

National Organization

No formal organization exists to direct a national program. Instead, we have representatives from selected Federal agencies who participate in providing policy and direction, as well as actually working with the airports in accomplishing bird control. Policy decisions, as they relate to civil airports, are developed by the Federal Aviation Administration's (FAA) Office of Airport Standards, with technical assistance being provided by the US Fish and Wildlife Service's (USF&WS) Animal Damage Control Branch. Through a Memorandum of Agreement between the FAA and the USF&WS, a working relationship has been established to provide an effective means of identifying vertebrate pest hazards and implementing procedures for planning, developing, and coordinating measures designed to minimize these hazards to the aviation industry.

The FAA and USF&WS have been working to identify problem airports, exchange technical data, conduct training sessions in bird control and to assist airports in implementing these airport bird control measures. The US Air Force is active in accomplishing the same tasks, with all three agencies cooperating with training. Since 1978, the USF&WS has sponsored seven workshops to train over 150 biologists and FAA and military personnel on the problems. The FAA has established regional bird hazard control groups that develop regional policies and implement national programs. These groups receive technical support from USF&WS biologists. Where a critical bird hazard exists, the group issues a Notice to Airmen, warning pilots of the hazard. The group can also take measures to restrict or discontinue use of the airport by air carrier aircraft. A single coordinator in each FAA region works with FAA field offices to identify airports with potential or serious bird hazard problems. These airports are then visited by a USF&WS biologist to identify bird attractants, making recommendations to the airport operator on how to reduce bird hazards.

Airport certification and safety inspectors and USF&WS biologists work side-by-side to resolve airport wildlife problems. The airport operator takes the initiative to implement bird hazard reduction recommendations and some of these airports have their own committees working to improve safety.

Airport Organizations

There are over 14,000 airports in the United States. Slightly less than half of these are public-use airports. However, only 731 airports are certificated to accomodate air carrier operations. Of these, 127 airports have a bird hazard problem and 3 additional airports have had collisions with deer. Since each airport is responsible for its own operation, the methods used in addressing bird hazards are as varied as the airports are themselves. The Federal government does not dictate to the individual airport operators the methods required to control birds, or the number of personnel needed. Airports that are served by air carriers must have the capability to control birds, but how they do bird control is dependent on their available resources.

Where airports have recognized that they have bird hazards, there is usually a formal organization established to handle the problem. This organization is a safety committee responsible for all aspects of airport safety; however, in some instances it is a special group composed of operations, maintenance, and planning personnel. With assistance from the USF&WS, the airport develops a plan to control the birds and coordinate habitate changes to reduce airport bird populations.

Airport Bird Patrols

The day-to-day responsibility for bird control belongs to the airport bird patrol. Few U.S. airports have bird patrols that operate full-time on the airfield. In most cases, the airports have individuals who are designated to respond to bird concentrations and disperse the birds. They must rely on tower personnel or pilots to provide the warning of any hazard. A problem with this type of operation is the poor response times and the lack of continuous harassment of the birds. Eight airports have full-time bird patrols, some are outstanding, others are ineffective.

Two Effective Bird Patrols

Portland International Airport, Oregon, and Seattle-Tacoma International Airport, Washington, are examples of airport with effective bird patrols. Both airports use highly motivated, well trained personnel and have successfully reduced the airport bird hazards. In contrast with many other civil airports, these two programs are exceptional because of the people involved. At Portland, for example, they use three people to provide bird control. These three operations coordinators work on a rotational shift to provide protection from before dawn to after sunset during most of the year, and increasing the patrol coverage during bird migratory seasons.

Portland's operations coordinators are responsible for all aspects of airport safety. They make runway checks, respond to emergencies, identify maintenance problems, and provide the eyes and ears for airport management on any problem relating to the safe operation of the airport. Their level of responsibility is such that they must be highly dedicated personnel. They are not just employees of the airport, but are essential members of airport management

who accept responsibility for the safe operation of the airport. None of the operations coordinators are biologists, but all are college graduates and had prior airport experience. They were all trained by USF&WS biologists and have progressed extremely well in developing effective bird dispersal techniques. They also work with the airport planning and maintenance staffs to develop habitat control techniques, relying heavily on recorded distress calls and pyrotechnic devices. They also conduct raptor trapping programs each year to reduce hawk and owl populations through capture and release away from the airport.

Seattle has a similar program, providing 24-hour coverage with 7 employees on a shift basis. Again, the key to Seattle's success is the quality of people doing bird control and their responsibility for all aspects of airport safety. Each member of the bird patrol carries all the necessary control equipment and patrols the entire airport on a routine basis. During the performance of other airport duties, they can be dispatched by radio to any location on the airport to control the birds. As with the personnel at Portland International Airport, the Seattle employees are well educated and experienced in airport operations.

Other Bird Patrols

Other airports that operate bird patrols frequently use personnel that are responsible for duties falling outside the realm of operational safety. These duties involve maintenance functions, security, dispatch duties, etc., which tend to reduce responsiveness to bird problems and require that the individual be away from the runway environment. In most cases, the bird patrol only patrols the airport when birds are observed congregating on the airfield. This is a highly undesirable situation, since an effective bird patrol is only possible with full-time harassment of the birds.

Some airports have a full-time patrol, but the patrol is ineffective because of personnel problems. A highly motivated individual is needed to achieve optimum bird dispersal. Of eight airport surveyed, only one has a biologist on its bird patrol. Most bird patrol employees had transferred from other airport duties and few enjoyed their new jobs. Common complaints were lack of training and responsibility, both of which could be corrected by airport management.

Local ordinances or regulations often interfere with bird control activities. In New York, city ordinances prohibit the discharge of a firearm by anyone other than an officer of the law. To use a shotgun for dispersal of birds requires the services of a policeman. When birds are observed on the airport, the patrol must call security and have a policeman dispatched to the runway area. This same problem occurs at four other airports, reducing the effectiveness of the bird patrol. The FAA is working with the local communities to resolve the problem.

Training

Besides the previously mentioned training for USF&WS and FAA personnel, training programs are being developed to provide instruction to anyone involved in bird control. Course materials are being prepared now for use in 1980-81 for training bird patrols. Annual sessions will be held on both coasts and the courses will be open to both military and civilian personnel. Our objective is to create a North American program similar to the course taught in the United Kingdom by the Ministry of Agriculture, Fisheries and Food. We anticipate participation by International Civil Aviation Organization (ICAO) member nations and plan to hold at least one training session in the Pacific area in 1981.

Advisory Circulars

The FAA's Advisory Circular System is the method that will be used to distribute information on bird control. As the national program on bird hazard reduction develops, information on bird control will be distributed. In preparation now are two circulars, one dealing with problems with bird hazards created by solid waste disposal facilities; the second dealing with airport inspection procedures to be used in identifying an airport bird hazard problem. By the end of 1981, we expect to distribute a comprehensive advisory circular that will cover all aspects of bird control, including staffing recommendations and training standards for bird patrols.

Research and Development

While the FAA has not been active in the recent past in bird research programs, this trend is rapidly being reversed, funding has been provided for:

1. An airport ecological analysis, leading to the preparation of a guide or checklist to identify bird hazard problems on airports.

2. A safety evaluation and product improvement analysis for shell crackers which is jointly sponsored by the US Air Force, USF&WS, and the FAA.

3. A state-of-the-art study of radar systems capable of detecting and warning the pilot of the presence of birds.

4. A bird banding program to document the extent of gull movements between solid waste disposal facilities and nearby airports.

In addition to these studies the US Air Force continues to fund the work being done by Dr. Gauthreaux on new methods of studying migration, as well as a study by another investigator on bird roost energetics.

There is always a need for continued research in bird hazard reduction. We will be concentrating our efforts on evaluating and improving control techniques, providing conclusive evidence as to their effectiveness. We cannot recommend that an airport use a particular method of bird control until we are convinced that it will work and will not interfere with the safe operation of the airport. The future for applied bird control research looks bright and all the data collected over the years will be shared with other nations through both the Bird Strike Committee Europe and ICAO.

Bird Strike Data

Exchange of bird strike data with other nations is essential. Feedback of data to the individual airports and aircraft operators is equally important. The FAA is committed to doing whatever is necessary to collect and disseminate important safety data. With ICAO's cooperation, the member nations are combining resources and data to make a more meaningful data base. When serious bird strikes occur, the pertinent data will be distributed to members of the BSCE and other selected nations, keeping them informed of American incidents. U.S. based air carriers operating world-wide often report bird strikes occurring in foreign countries. These reports will be processed and mailed to BSCE representatives as they are received. A recent change in our FAA Bird Strike/Incident reporting form has already yielded a 115% increase in voluntary reporting. Computerization of the data will further facilitate data exchange.

The Future for Bird Hazard Reduction

The FAA's aggressive role in establishing a national bird hazard reduction program - and the enthusiastic support provided by the USF&WS - will lead to a strong national program. Our goal is to improve bird control at the airports. Secondary to this are studies relating to migration and enroute bird hazards. We will continue to work with other Federal and state agencies to effect compatible land use around airports. Through the exchange of information with other countries, we hope to capitalize on their experience and build a program to meet the needs of American airports in controlling birds. By 1981, we will be prepared to provide all necessary assistance to airports when needed.

Direct financial assistance is available to airports through the Airport Development Aid Program, paying a major percentage of necessary habitat changes to reduce bird attractants. An expansion in the use of Federal funds in bird control is expected. Although we provide both technical and financial assistance to airports, it is the airport's responsibility to take necessary action in controlling their birds. The degree of success realized in airport bird control is dependent then on the degree of emphasis placed on bird control by airport management.

IN SEARCH OF A MOTIVATED BIRD PATROL

Since September 1978, data has been collected on airport bird patrols to determine how effective the patrols are at dispersing birds. Eight airports with bird patrol units were inspected over the course of a year. Following evaluation of their effectiveness, each member was interviewed to determine both positive and negative aspects of their job. Table 1 provides the essential employment and operations data. All airports examined are considered medium to large size airports with serious bird hazard problems.

TABLE 1

BIRD PATROL DATA

AIRPORT	1978 OPERATIONS	FULL-TIME PERSONNEL	PART-TIME PERSONNEL	SHIFT HOURS/DAY	SHIFT DAYS/WEEK	SALARY RANGE
A	340,000	3	1	8	5	14-30,000 [1]
B	220,000	-	3	8	5	-
C	370,000	2	1	8	5	14-30,000 [1]
D	210,000	2	1	8	5	14-30,000 [1]
E	230,000	3	1	10	4	15-22,000
F	380,000	2	1	8	5	14-18,000
G	250,000	-	5	8	5	20-31,000 [2]
H	350,000	-	3	8	5	20-31,000 [2]

1. Includes cost of police officer required to discharge firearms.
2. These are airport operations officer positions.

Each airport provides 7 day/week coverage by using 4-5 day rotational shifts.

SUMMARY - AIRPORT A

This airport experiences the greatest problem with bird hazards. Two full-time personnel patrol the airfield from before dawn to after sunset. They spend two weeks on the airfield and then change for two weeks, performing other operational safety duties. The part-time worker augments the staff. One member of the patrol is a police officer, required under city ordinances if a shotgun is to be used. Shellcrackers and live ammunition are the preferred method of control, although other noise producing devices are used.

SUMMARY - AIRPORT B

This airport only uses a part-time patrol composed of airport operations personnel. They only respond when birds are observed to be in a hazardous position on the airport and either reported by tower or aircrew personnel. Shellcrackers and live ammunition are used exclusively.

SUMMARY - AIRPORT C

Essentially the same operation as Airport A, except that personnel assigned to do bird patrol do nothing else, and only locate birds on the airport. They then call the airport police to conduct the actual dispersal.

SUMMARY - AIRPORT D

Same as Summary - Airport G

SUMMARY - AIRPORT E

This is an excellent operation, using one individual shift, two shifts/day, getting 20 hours coverage daily. All three individuals perform duties other than bird control, but all duties are safety related. They are continuously patrolling the airport. The part-time employee is a biologist whose duties primarily concern hawk trapping and relocation. Distress calls and pyrotechnic devices are used.

SUMMARY - AIRPORT F

This airport kills birds routinely and claims that other techniques are ineffective. The two full-time individuals rotate shifts and are augmented by another individual when necessary. When they are on the airport, they are only responsible for bird control;however, they may be removed from this duty to perform other airport duties (snow removal, lighting maintenance, etc.) The airport uses the services of a consulting ornithologist.

SUMMARY - AIRPORT G

This airport uses operations personnel who are dispatched from an office to where birds are congregating. After they determine the problem, they request assistance from the airport police to disperse the birds. Shellcrackers and live ammunition are used exclusively.

SUMMARY - AIRPORT H

Same as Airport G except that gas cannons are also used.

OBSERVATIONS

Overall, bird patrols at these airports are somewhat ineffective - with the notable exception of Airport E. Key problems are:

1. Lack of full-time harassment of the birds (Airports B,C,D,G,H).

2. Inability to apply control techniques by the bird patrol because of imposed restrictions on the use of firearms (Airports A,C,D,G,H).

3. Failure to use an adequate combination of control techniques, including noise producing pyrotechnic devices and/or recorded distress calls (Airports A,B,C,D,F,G,H).

4. Inadequate equipment (Airports A,B,C,D,F,G,H).

5. Frequent changing of personnel (Airports B,D,G,H).

6. Lack of training (Airports A,B,C,D,G,H).

7. Lack of biological expertise (Airports A,B,C,D,G,H).

8. Bird control responsibilities are low on airport safety priorities (Airports A,B,C,D,G,H).

9. Low morale of bird patrol personnel (Airports A,C,D,F).

10. Lack of potential for advancement (Airports A,C,D,F).

11. Job disatisfaction (Airports A,C,D,F).

Without exception, there is a need for better training of U.S. bird patrol personnel. Better training will lead to acquisition of better equipment, once the bird patrols realize what techniques can best be used in controlling their birds. Without the benefits of formal training, personnel lacking biological expertise are ill-prepared to use these various control techniques effectively. Better training will also identify the need for continuous monitoring of bird movements on and off the airport. Part-time bird control is ineffective when birds are always found on the airport. If properly trained, however, some airports could continue to use a part-time patrol, providing it is fully equipped and capable of responding with minimal delay.

A totally unsatisfactory condition exists when the bird patrol must call the airport police to discharge firearms. It causes delays in response times, removes the responsibility of bird control from the bird patrol and leaves the patrol without the benefits of knowing that they can do their job and do it well. The bird patrol must be able to do all aspects of control, from observation to actual scaring. The requirement to use other personnel to fire weapons not only reduces the bird patrol personnel's job satisfaction, but increases the cost of bird control. Overall effectiveness can be improved

by eliminating excess personnel and expanding the responsibilities of the bird patrol member.

When job satisfaction was discussed at Airports A,C,D, and F, frequent complaints were lack of responsibility, the lack of promotion potential, lack of emphasis on the importance of the job function and low morale. An answer to the job satisfaction problem is increased levels of responsibility. When members of the bird patrol had other safety related responsibilities, working conditions were vastly improved. They felt that with additional responsibilities, they could demonstrate performance in other areas of airport operations, improving their chances for advancement. At one airport, the opposite situation existed Patrol personnel were taken from the maintenance shop and looked upon bird patrol duties as being undesirable because it removed them from chances for advancement within their technical trade.

The Ideal, Motivated Bird Patrol

Airport E represents this ideal patrol. Airport E is Portland International Airport and is identified so that other airports may visit this airport in Oregon, observing first-hand how they operate. The three bird patrol members are motivated because they are 1) trained to do their job, 2) supported by airport management, 3) have broad responsibilities for airport operational safety, and 4) are receiving the necessary work experience which can lead to professional development and advancement. The three employees are classified as airport operations coordinators.

Reviewing the eleven problem areas observed at other airports, we find that at Portland International Airport:

1. Full-time bird harassment is achieved because the operations coordinators are always on patrol, working all types of operational safety programs.

2. The operations coordinators are not restricted in the tools or methods used in bird control (consistent with wildlife laws). They enjoy the opportunity to experiment with new techniques.

3. Portland International Airport uses a variety of techniques, but relies heavily on distress calls, shellcrackers and other noise devices.

4. The airport has equipped a special vehicle for use by the operations coordinator. Radios, tape playback equipment, spotlights, shotguns, and traps are all carried and readily available at a moments notice.

5. There has not been, nor is there expected to be a heavy turnover in operations coordinators. They each enjoy their job and are learning about airport operations and management. Advancement to positions of greater responsibility are likely. Any vacant positions will be filled by personnel trained by other operations coordinators.

6. The operations coordinators were trained by biologists to do bird control, have attended a ground school for private pilots and received training on airport operations from their supervisors and the FAA.

7. Although they lack formal training in the biological sciences, one member of the group has devoted her time to studying bird biology on a self-study basis. When a problem occurs and they are not sure why the birds are attracted to the airport, they seek help from local biologists. During a recent hawk problem, the airport contracted for hawk trapping and requested assistance in rodent control.

8. While bird control does not receive the highest airport priority, operational safety does. Since the operations coordinators are responsible for a wide variety of safety activities, their total program receives top level support from airport management.

9. Their morale is excellent because of their high degree of job satisfaction.

10. Potential for professional advancement exists because of experience gained in the operation of airports.

11. All of these positive factors combine to produce high morale, professional motivation and quality bird control.

CONCLUSIONS

On US civil airports two types of bird patrols are needed, the first being a part-time capability to respond to bird problems at airports that don't have a serious bird hazard problem. The second is the need for full-time coverage by a bird patrol to effectively reduce bird populations through dispersal, trapping or by lethal means. This second type of bird control can best be accomplished by a bird control unit that operates continuously on the airport. To hire quality personnel, there must be a level of responsibility that is substantial enough to justify a descent salary and provide for advancement. This can be done by following the example of Portland International Airport and several other airports who have placed operations personnel in vehicles to perform full-time safety patrols. Pavement and lighting problems, unsafe taxiing activities, runway friction conditions, airport vehicular traffic problems, and construction activities can all be monitored by a mobile operations unit. If this unit is equipped and trained to conduct bird control and bird control receives the same priority as other airport safety problems, then the airport's bird hazard reduction program will be effective.

The FAA will continue to work with airports in developing quality bird patrols. However, the airports must recognize the need for quality airport safety personnel and avoid the use of people with limited airport experience and no training in bird control. We have a responsibility to assist in training and inspection of airport bird control programs. These two items will receive the highest priority in the national bird control program.

BSCE I4/WP7

RECHERCHES EN COURS SUR LES MIGRATIONS DES OISEAUX ,
- départs de Camargue au printemps et arrivées de migrateurs sur la côte méditerranéenne française .

Par Marc LATY
(STNA 2N, FRANCE)

Communication présentée à la I4ième réunion du BIRD STRIKE COMMITTEE EUROPE tenue à LA HAYE du 22 au 26 Octobre I979.

RECHERCHES EN COURS SUR LES MIGRATIONS DES OISEAUX :

- départs de CAMARGUE au printemps,

- arrivées sur la côte méditerranéénne.

(par Marc LATY , STNA 2N , FRANCE)

Au cours de la rédaction des MESSAGES BIRD WARNING, je me suis souvent trouvé devant la nécessité de connaitre quelles étaient les modalités suivant lesquelles les migrateurs franchissent certains grands ensembles géographiques.

Aussi ai - je utilisé la détection par radar pour rechercher quel pouvait être le comportement des oiseaux en cours de migration. Cela , pour connaitre la façon dont ils conduisent leurs vol et , par cette connaissance , essayer de fournir une meilleure information aux services chargés de tenir compte de l'obstacle constitué par les migrateurs pour les aéronefs.

Dans la première partie de cette étude, je me suis limité au cas des oiseaux prenant leur vol à partir du DELTA DU RHONE et à celui des oiseaux arrivant par mer sur la côte méditerranéénne française, au cours de la migration prénuptiale.

Les données ont été obtenues à partir de l'enregistrement cinématographique continu de l'image d'un radar de surveillance , au CENTRE REGIONAL DE LA NAVIGATION AERIENNE SUD - EST , à AIX EN PROVENCE, au cours des années I970 et I973.

La portée utile de ce radar peut aller jusqu'à I00 kilomètres pour la surveil--lance des déplacements d'oiseaux. La " couverture ornithologique " de ce radar permet de détecter et de fournir une bonne visualisation des déplacements d'oiseaux dès leur départ de CAMARGUE et de les suivre sur une longue distance. Par ailleurs, des oiseaux arrivant par mer peuvent être observés sur un large front et suivis au cours de leur progression, en deçà et au delà de la ligne de côte , sur près de 200 Kilomètres.

R E S U L T A T S

I. MIGRATEURS AU DEPART DE CAMARGUE.

Les départs s'échelonnent de la fin janvier à la mi - mai. Au cours de cette saison de migration, les migrateurs prenant leur vol peuvent être des oiseaux quittant leur quartier d'hivernage ou bien , des oiseaux en cours de migration. Pour ces derniers, la CAMARGUE ne représente qu'une étape.

I. 1 Chronologie des départs.

Les départs de Camargue se sont tous produits en fin de journée, (graphique 1).

Le délai entre les premiers envols et le coucher du soleil est au minimum de plus ou moins 4 minutes et au maximum de plus I5I minutes et de moins 67 mn.

I. 2 Durée des départs.

La durée maximale a été de 5 h42 en I970 et de 4 h 55 en I973 ; la durée mini--male pour ces deux années de 1 heure, (Graphique 2).

I. 3 Densité des migrateurs.

L'importance du départ migratoire peut être évaluée par la densité maximale d'échos d'oiseaux observés sur l'écran de radar.

Au cours des années I970 et I979 , 26,5 % des départs de CAMARGUE se sont pro--duits avec une densité de migrateurs faible (entre 0,00I8 et 0,0037 écho par Km^2), 53,1 % avec une densité moyenne (entre 0,0075 et 0,030 écho par Km^2) et 20,4 % avec une densité forte (entre 0,060 et 0,24 écho par Km^2); (graphique 3).

I. 4 Délai entre début du départ et maximum de densité.

Le maximum de densité a été observé dans 59,I8 % des cas au début du départ migratoire, 24,48 % des cas dans l'heure suivante, I4, 28 % des cas dans la seconde heure et dans 2,04 % des cas dans la troisième et la quatrième heure , (Graphique 4).

I. 5. Cap suivi.

L'ensemble des départs se situent avec des caps compris dans les secteurs NNE et ESE pour les deux années considérées, avec un cap à l'Est préférentiel (28,37% én I970 et 50 % en I973 des départs se font cap à l'Est) , (Graphique 5).

I. 6. Vitesse.

La vitesse par rapport au sol des migrateurs après leur départ de CAMARGUE a été évaluée, pour les plus lents à 55,5 kilomètres et pour les plus rapides à 75 kilomètres par heure.

II. MIGRATEURS ARRIVANT PAR MER .

Ces déplacements s'échelonnent de la fin janvier à la fin mai.; 40 arrivées ont été dénombrées en I970 , 54 en I973.

II. 1. Chronologie des arrivées.

Les arrivées par mer débutent soit à l'aube soit en fin de journée.

En I970 , 32 arrivées ont commencé à l'aube, 8 en fin de journée ; en I973, 32 à l'aube et 22 en fin d'après midi, (Graphiques 6,8).

La durée maximale des arrivées matinales a été de II h 50 en I970 et de II h 55 en I973, la durée minimale a été respectivement de I h 20 et de2 h 05.

La durée maximale des arrivées vespérales a été de I3 h en I970 et deI6 h 20 en I973, la durée minimale a été respectivement de 6 h I0 et 3 h 50, (Graphiques 7,9)

II. 3. Densité des migrateurs.

Pour les années I970 et I973, parmi les arrivées matinales , 25 % étaient de densité faible, 54,6 % de densité moyenne et 20,3 % de densité forte.

Parmi les arrivées vespérales, la fréquence relative des densités faibles , moyennes et fortes a été respectivement de 33,3 , 46,6 , et 20 %, (Graphiques 10,11).

II. 4. Délai entre début de l'arrivée et maximum de densité.

Pour les arrivées matinales, le maximum de densité a été observé dans 54,68% des cas au moment du début de l'arrivée , I2,5 % des cas dans l'heure suivante , 7,8I % des cas dans la seconde heure, 3,I2 % dans la troisième heure et I4,06 % au delà de la troisième heure.

Pour les arrivées vespérales, le maximun de densité a été observé dans 56,66 % des cas au moment du début de l'arrivée, 20 % des cas dans l'heure suivante, I0 % des cas dans la troisième heure et dans I3,3 % des cas au delà de la troisième heure, (Graphiques 12,13).

II. 5. Cap suivi.

L'ensemble des arrivées s'est fait avec des caps compris entre les secteurs NNO et NNE pour les deux années considérées, avec un cap légérement plus à l'est en I973,(Graphiques I4 ,I5).

II. 6. Vitesse.

La vitesse par rapport au sol des migrateurs à leur arrivée par mer a été évaluée pour les plus lents à 46,3 kilomètres et pour les plus rapides à 83,3 kilomètres par heure.

INTERPRETATION DES RESULTATS

Des migrateurs inféodés aux milieux aquatiques hivernent en Camargue. Dès la fin janvier certains de ces oiseaux commencent à quitter le Delta du Rhône pour regagner leurs lieux de reproduction. Pour d'autres oiseaux migrateurs la Camargue sert seulement d'étape.

Les départs migratoire de Camargue ont été observés à la tombée de la nuit.

C'est aussi la période du jour à laquelle beaucoup d'oiseaux aquatiques quittent leurs remises diurnes pour aller sur les lieux de gagnage nocturne.

Le même soir les envols de migrateurs se produisent pendant plusieurs heures.

La densité instantanée des échos d'oiseaux varie pendant cette période. Une densité maximale est observée dans près de 60% des cas au moment du début du phénomène de départ migratoire. Il n'a jamais été constaté,pendant les saison étudiées ,plus d'un maximum de densité par départ migratoire.

Le déplacement de l'ensemble des oiseaux participant au même départ migratoire se fait suivant des caps identiques. D'un départ à l'autre, le cap peut varier mais reste dans les secteurs N.N.E. et E.S.E.

La fréquence plus élevée des départs de Camargue, cap à l'Est, semble montrer que le survol du Massif Alpin se fait au niveau des Alpes du Sud. Il peut être ainsi évité, pour les oiseaux aquatiques gagnant le nord de l'Italie, et par la suite les zones humides d'Europe Centrale.

A l'intérieur de la couverture radar utilisée, il n'a pas été constaté de modification dans le cap suivi par les migrateurs après leur départ de Camargue.

Au printemps, les arrivées de migrateurs par mer se produisent en début ou en fin de journée. Dans les deux cas, elles se poursuivent pendant plusieurs heures.

Au cours de cette période, la densité instantanée des échos d'oiseaux varie. Dans près de 55% des cas, ce maximum est observé au moment du début du phénomène.

Les arrivées matinales se font suivant des caps compris dans les secteurs NNO à NNE . Une fréquence relative plus élevée pour les caps NNE, NE, ENE, et NNO est constatée.

Pour les arrivées vespérales, les caps suivis sont compris dans les secteurs NO à ENE , avec une fréquence relative plus élevée pour les caps NNE.

Au cours du déroulement du passage des migrateurs dans la couverture radar, il n'a pas été observé de modification de cap à l'approche de la côte ou des massifs montagneux.

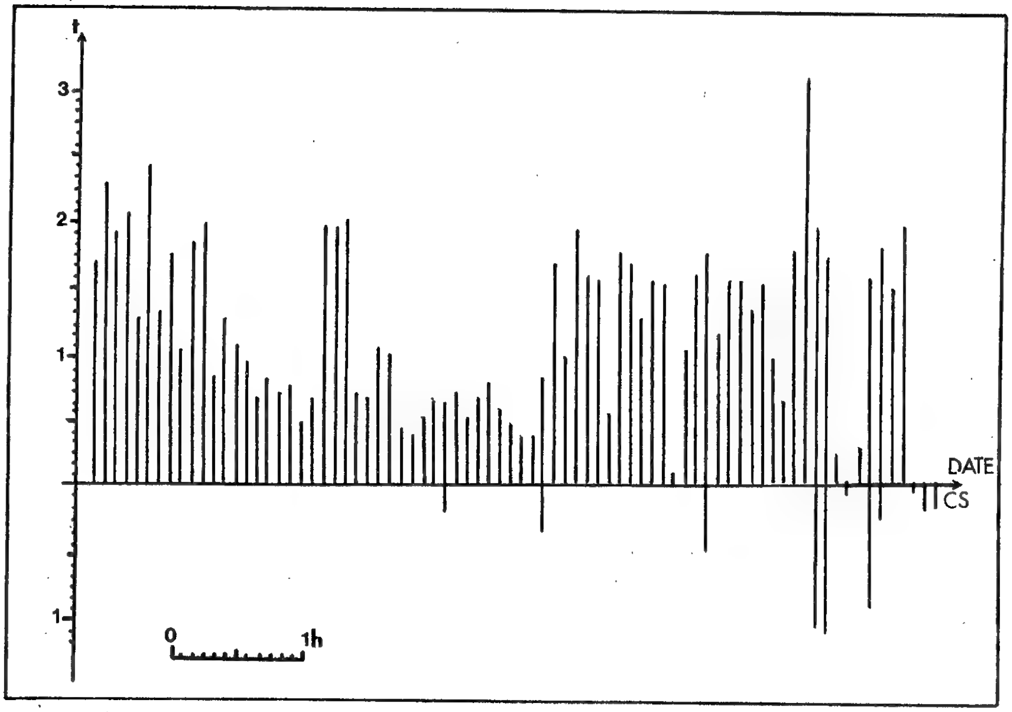
Il a été supposé qu'à ces caps correspondent des zones de départs situées en amont suivant la direction de migration. Par analogie avec les départs de Camargue observés en fin de journée, il a été aussi supposé que les arrivées matinales et vespérales pouvaient correspondre à des départs, soit à l'aube, soit à la tombée de la nuit.

En fonction de la vitesse par rapport au sol, de l'heure à laquelle l'arrivée a débuté et du cap suivi , il est alors possible de situer sur la carte, des zones de départs probables. Dans l'ensemble, ces zones se répartissent sur le pourtour méditerranéen et couvrent la Péninsule Ibérique, le Nord de L'Afrique et les Iles Méditérranéennes.

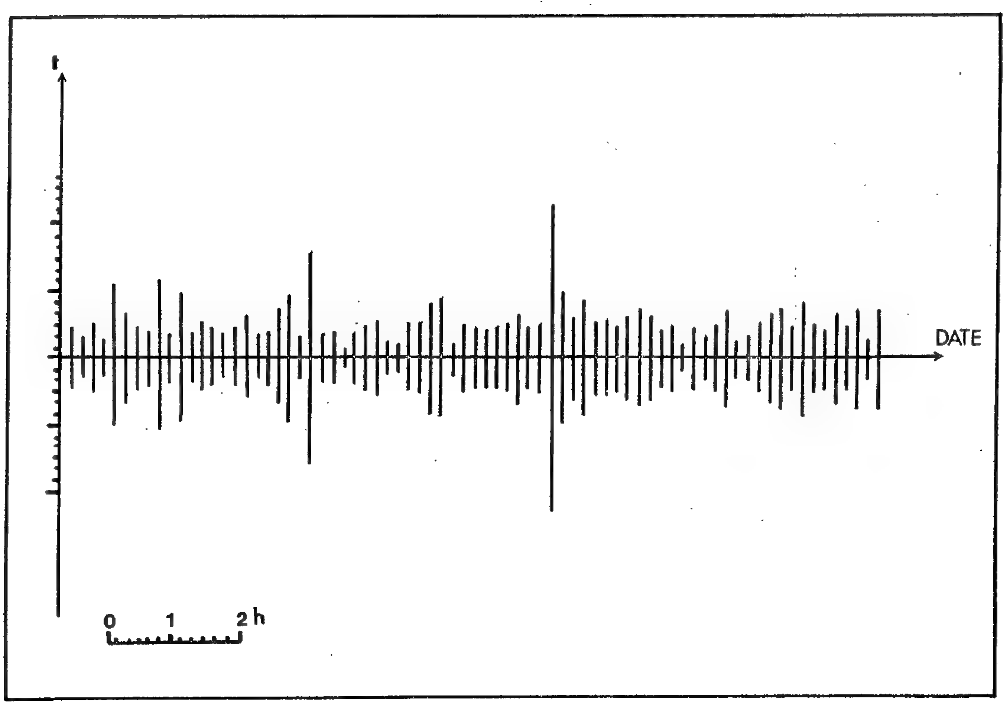
A l'arrivée sur la côte, les migrateurs poursuivent leur vol ou se posent. Suivant la date par rapport à la saison de migration, il semble que la progression à l'intérieur du continent, soit d'autant plus importante que la saison est plus avancée et que les conditions atmosphériques sont moins défavorables.

Dans les cas de départs migratoires de Camargue ou dans ceux d'arrivées de migrateurs par mer au printemps sur la côte méditérranéenne française, il est tenu compte de l'ensemble de ces données, pour l'interprétation de la migration en cours et pour la rédaction des Messages Bird Warning.

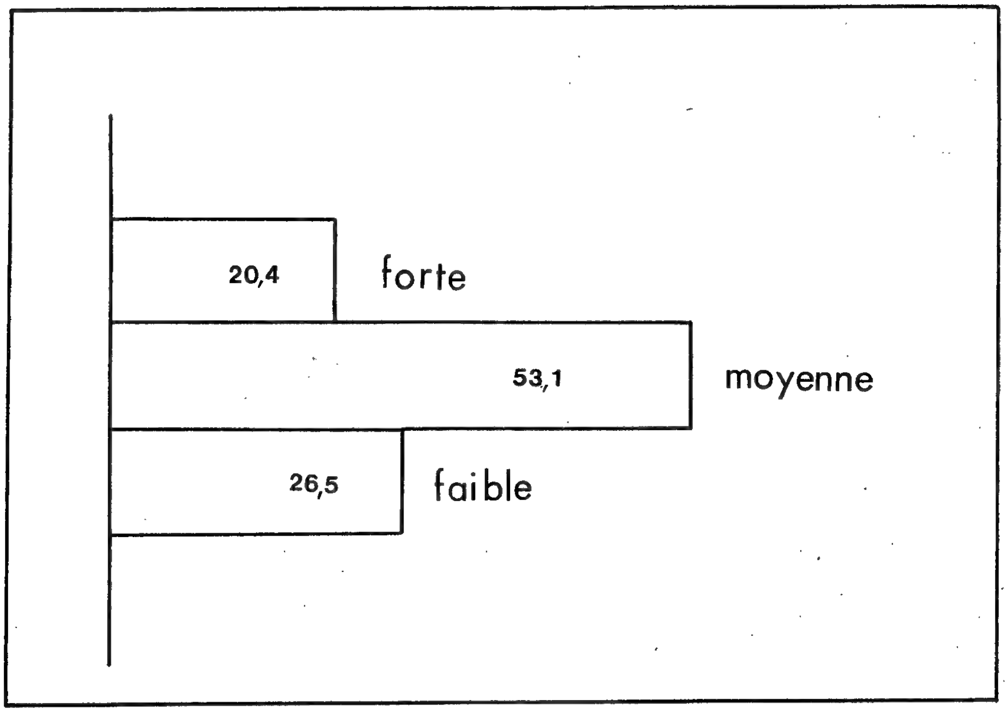
Ces deux types de déplacements migratoires ne sont pas les seuls à se produire dans le sud de la France; d'autres données sont actuellement étudiées. Elles permet--tront de fournir une information plus précise et plus complète aux Services chargés de tenir compte de l'obstacle constitué par les oiseaux pour les aéronefs.



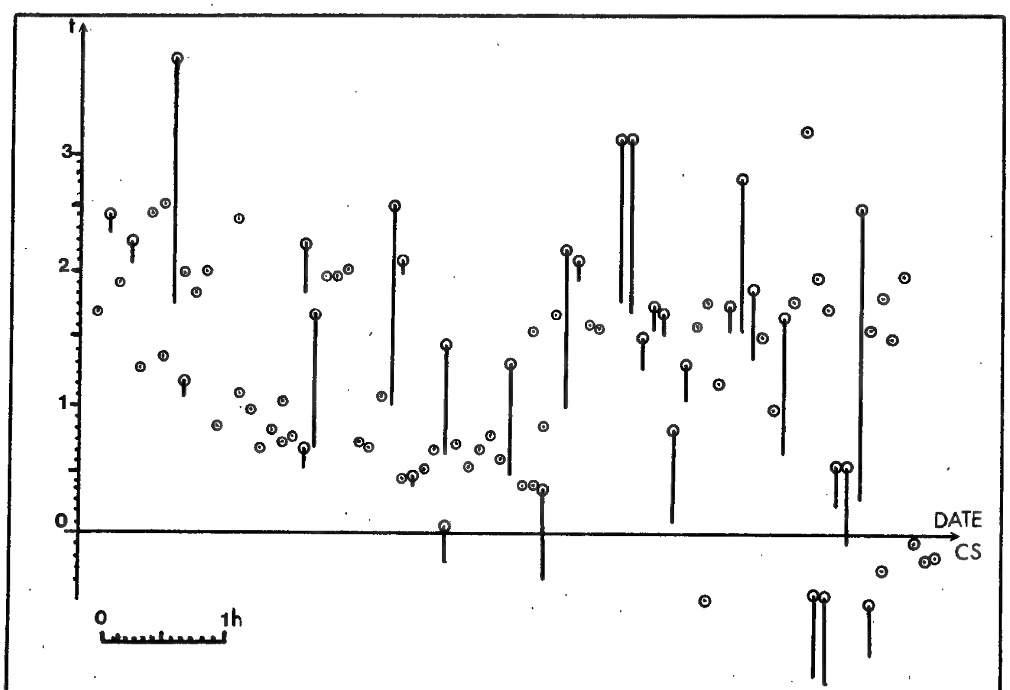
1



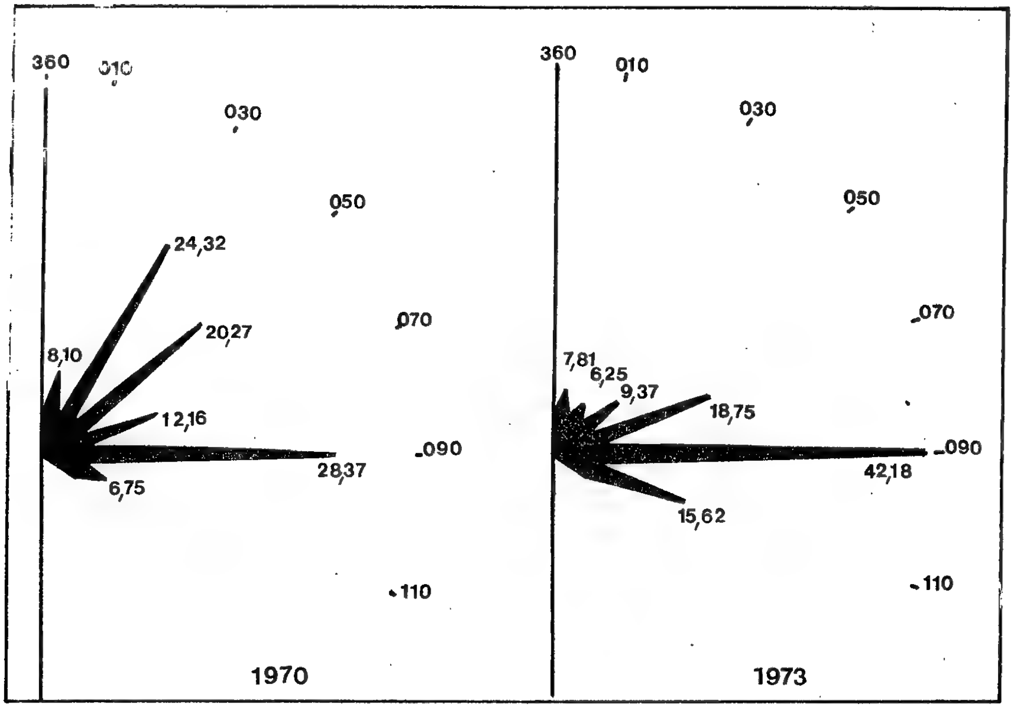
2

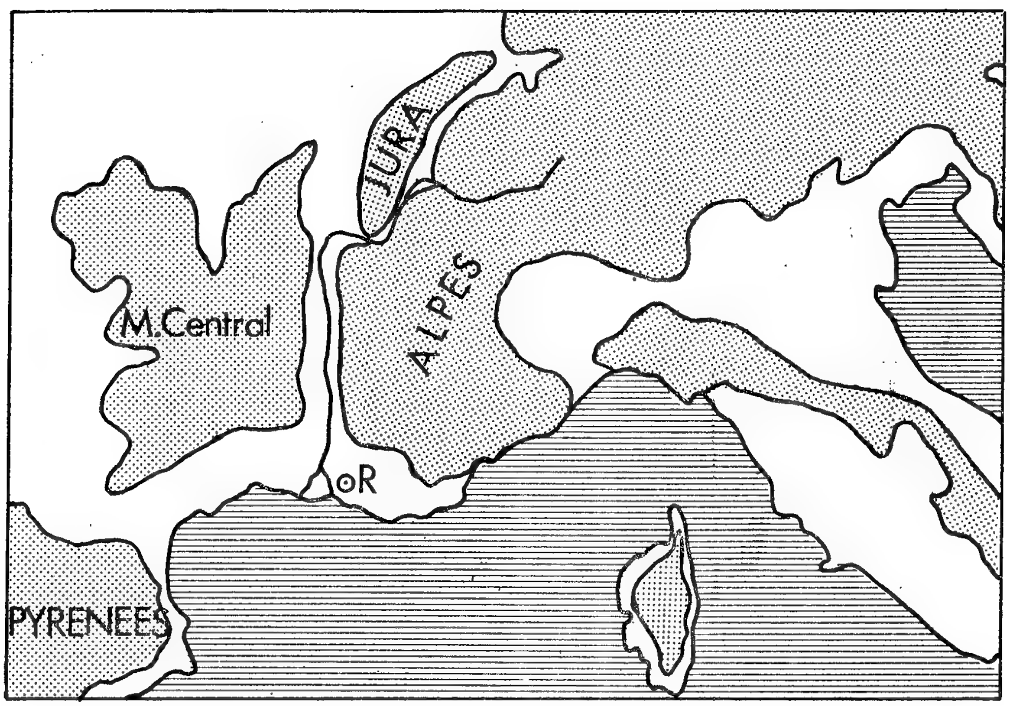


3

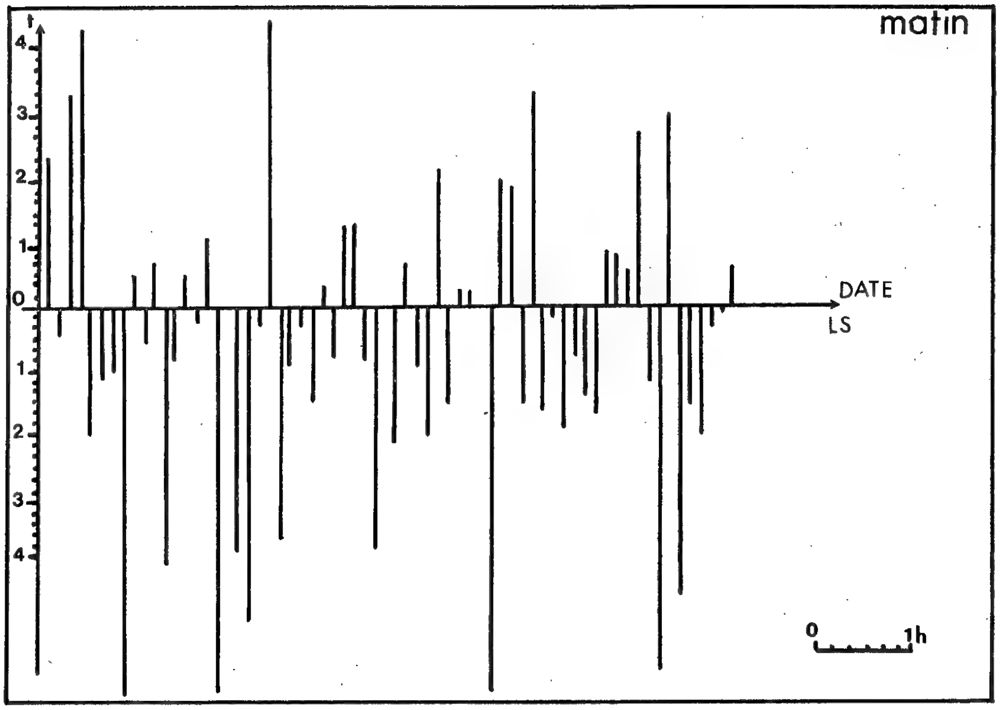


4

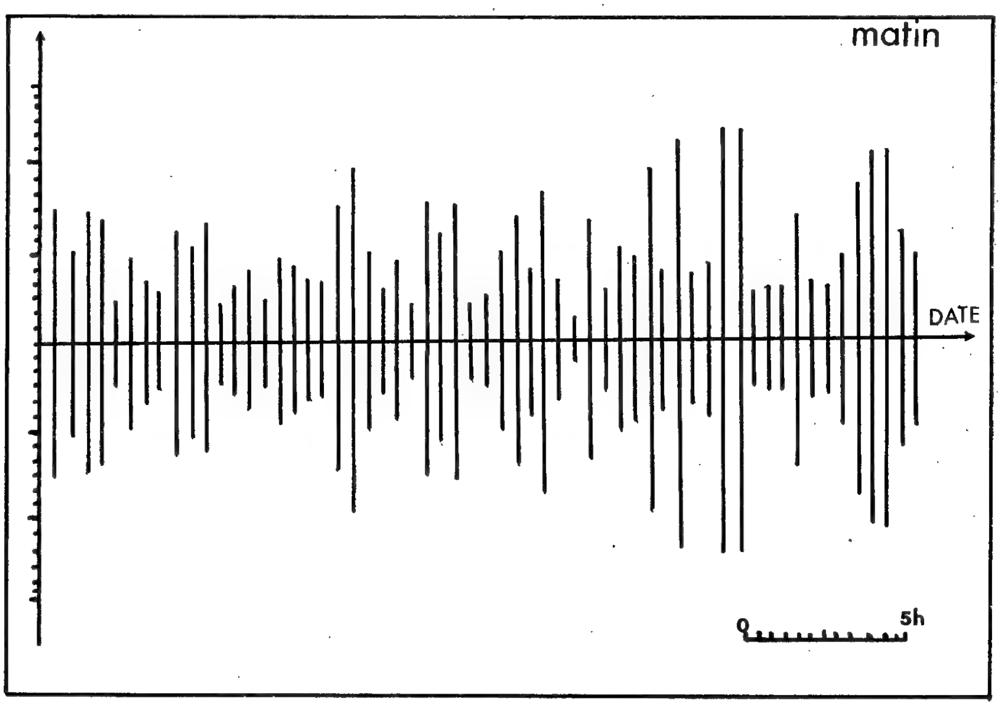

360
010
030
050
070
090
110
24,32
20,27
8,10
12,16
28,37
6,75
1970
360
010
030
050
070
090
110
7,81
6,25
9,37
18,75
42,18
15,62
1973


JURA
M.Central
ALPES
oR
PYRENEES

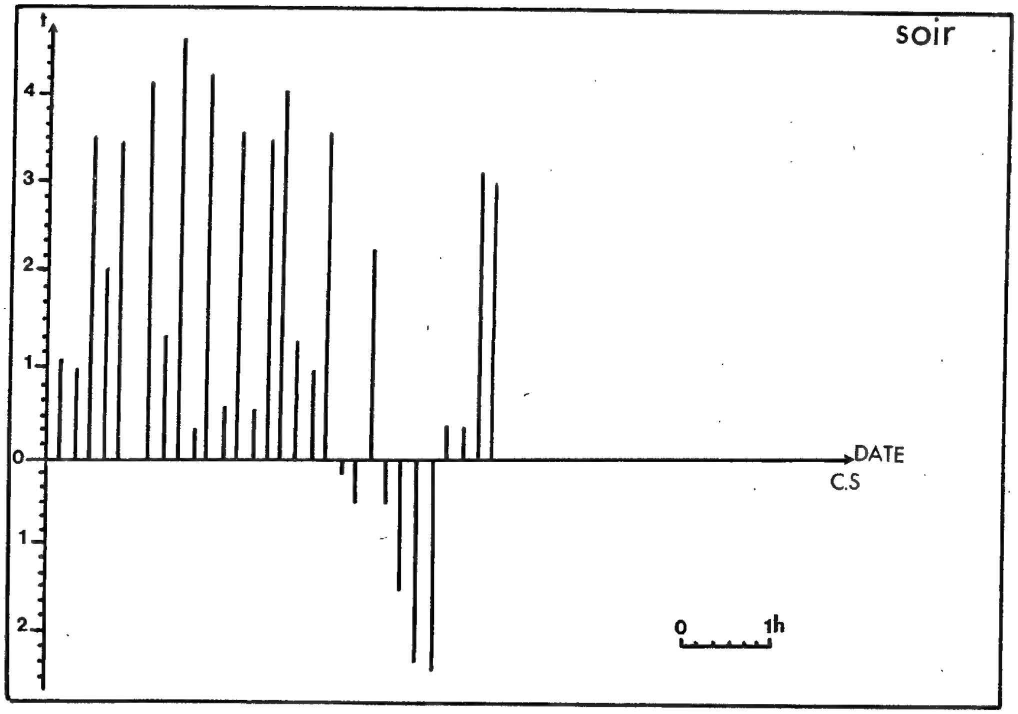
5



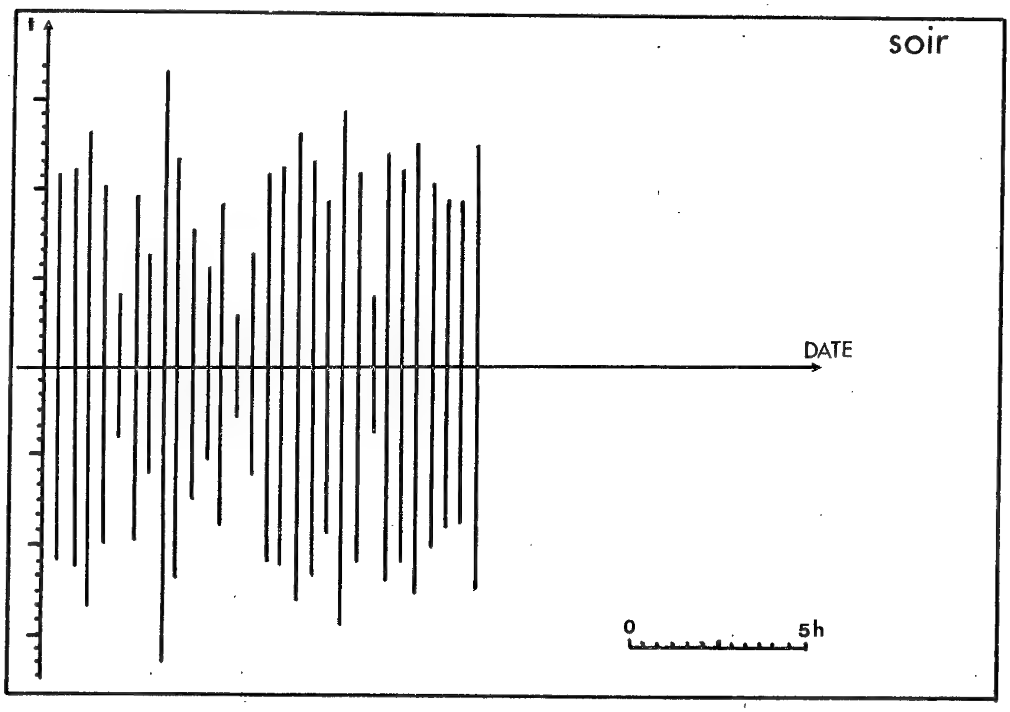
6



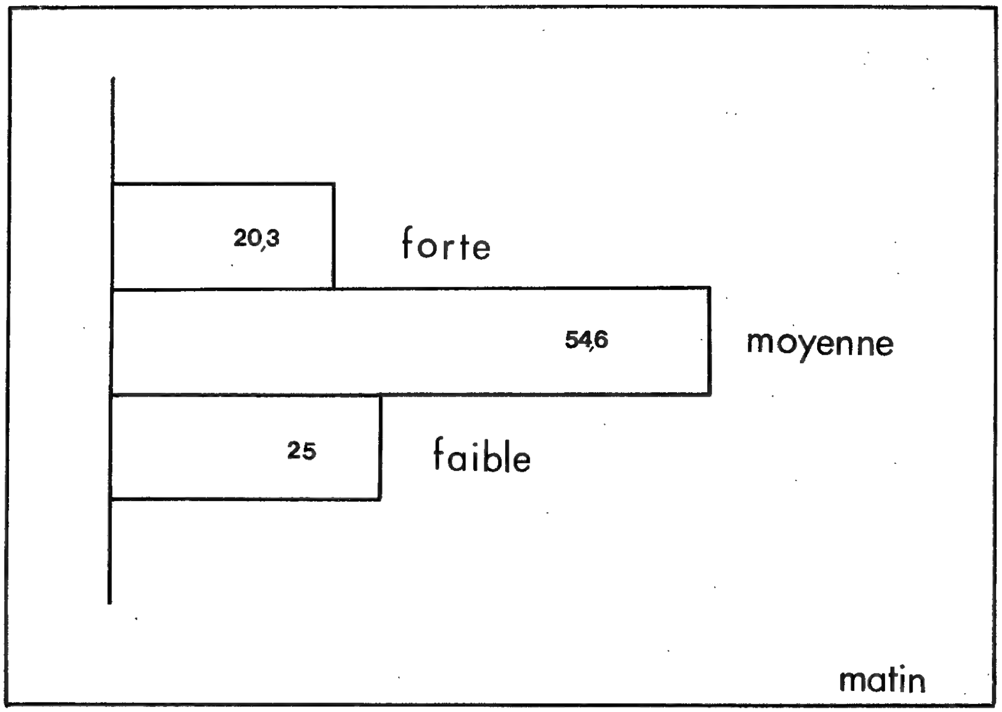
7



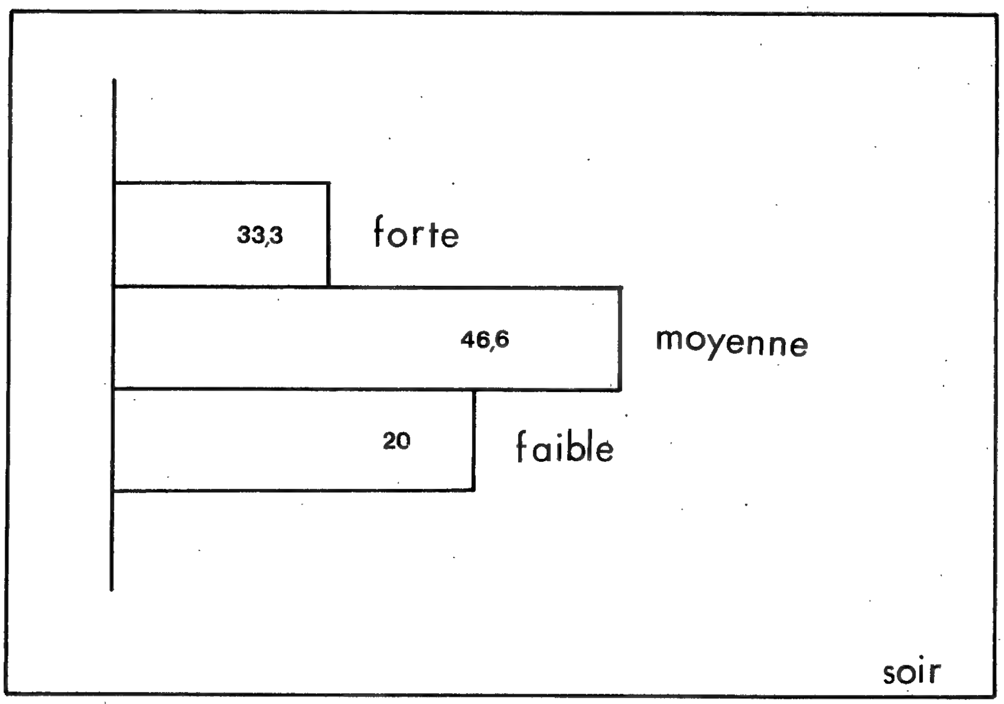
8



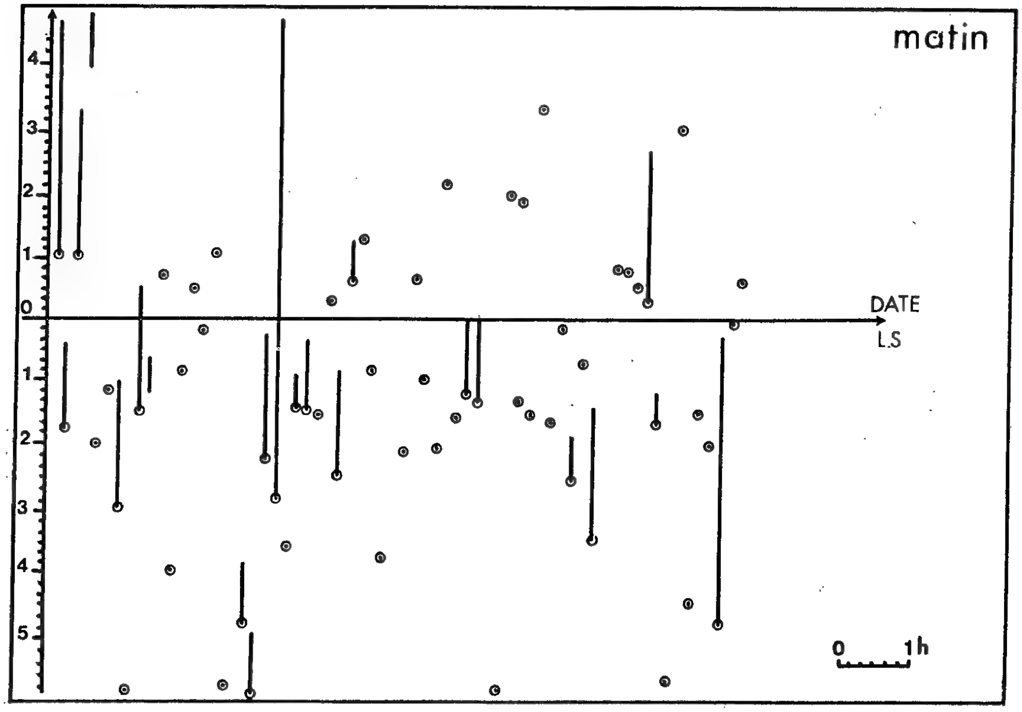
9


20,3
forte
54,6
moyenne
25
faible
matin

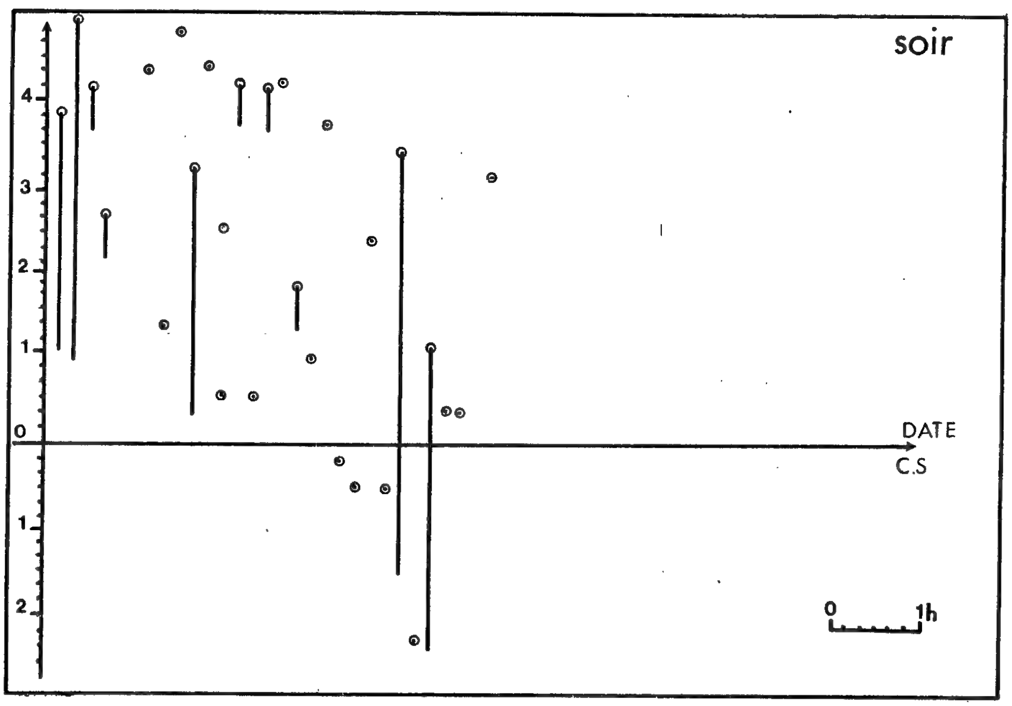
10


33,3
forte
46,6
moyenne
20
faible
soir

11

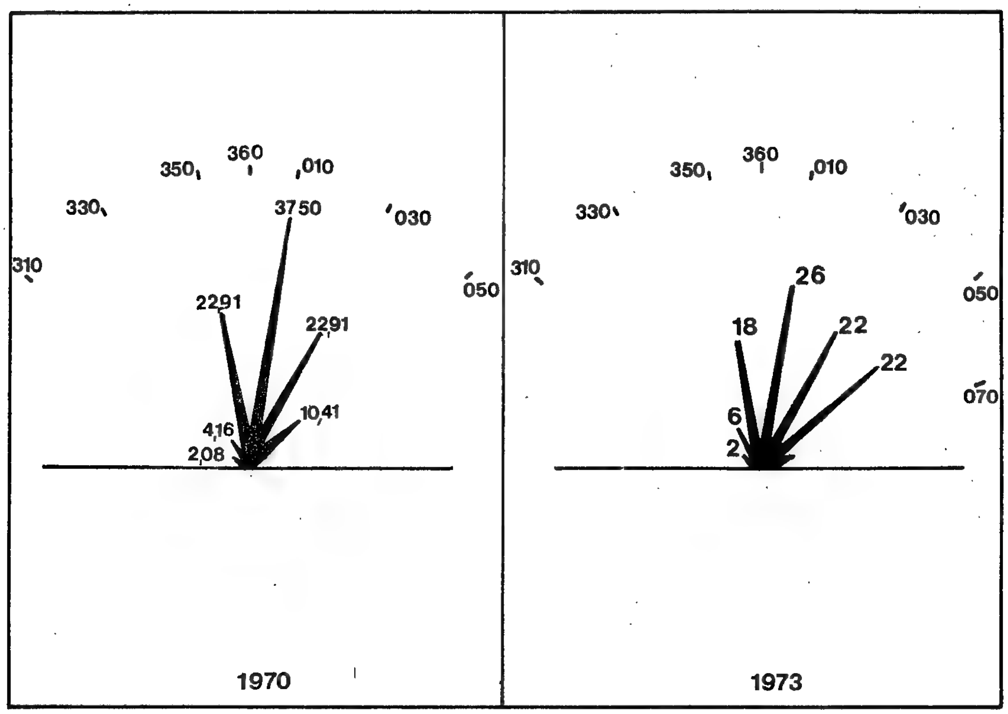


12

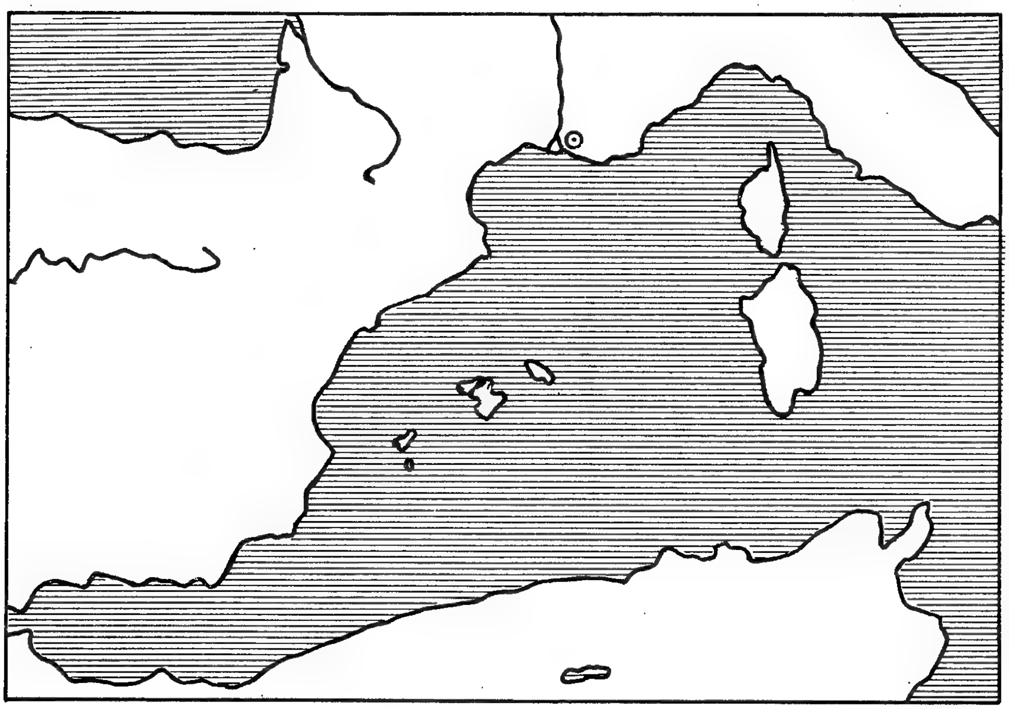


13

13

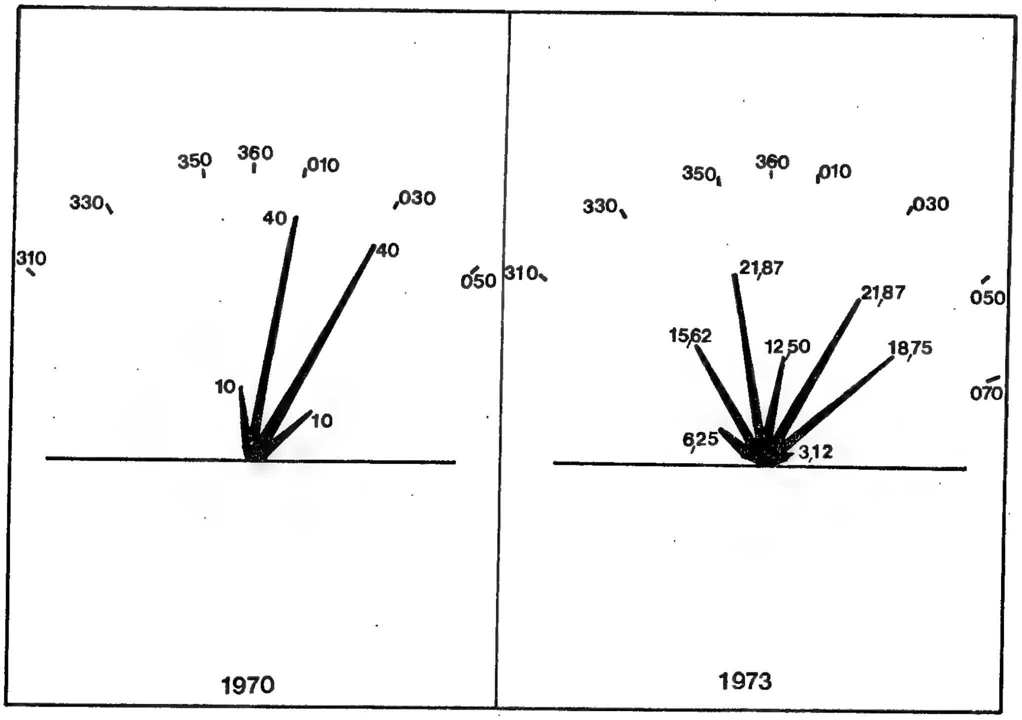


350
360
010
330
3750
030
310
2291
050
2291
10,41
4,16
2,08
1970
350
360
010
330
030
310
26
050
18
22
22
070
6
2
1973

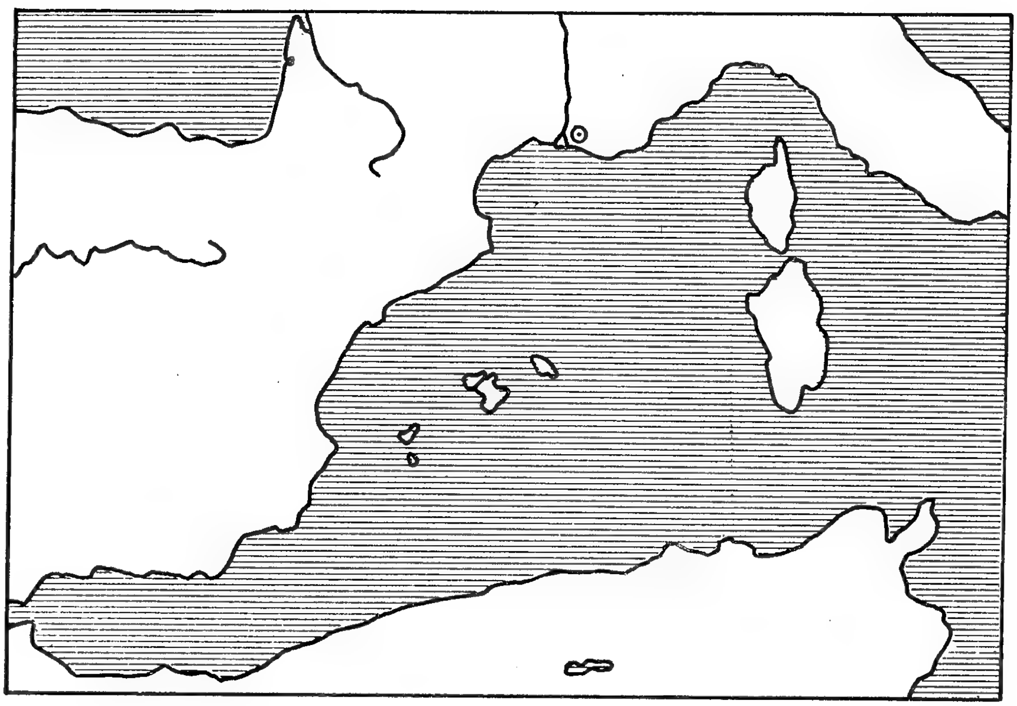


14

14



350
360
010
330
030
310
050
40
40
10
10
1970
350
360
010
330
030
310
050
070
21,87
21,87
15,62
12,50
18,75
6,25
3,12
1973



15

AD F 616 086

BSCE 14 / WP 8

IMAGE INTENSIFICATION: A NEW METHOD OF STUDYING NOCTURNAL BIRD MIGRATION

Sidney A. Gauthreaux, Jr.
Department of Zoology
Clemson University
Clemson, South Carolina 29631

ABSTRACT

This presentation will discuss a new technique of detecting, monitoring, and quantifying the density of nocturnal bird migration. The apparatus takes advantage of the latest developments in the field electro-optics and the system is composed of an image-intensifier (AN/TSV-5), a low-light level closed circuit television camera, a video tape deck. The image-intensifier amplifies incoming light by a factor of 50,000 and has a magnification of 6.3 power. In geographical areas with sufficient ground light, the apparatus may be directed skyward to detect migrating birds flying aloft and very dimly illuminated from the ground below. In areas without ground lighting, a narrow beam 300 watt spotlight can be directed vertically to provide sufficient illumination.

Initial tests indicate that the technique readily detects even small nocturnal migrants at considerable altitudes above ground level, and larger birds (e.g. waterfowl) can be observed migrating at even greater altitudes. Analysis of the migratory movements can be made directly and immediately from the television video monitor, or analysis can be completed at later time from the video tape. A brief 16-mm film made directly from the television monitor will demonstrate the capability and utility of the technique. Additional applications of this new technique will be discussed.

INTRODUCTION

Ten years ago I published a paper on the use of a vertical ceilometer light beam to study low altitude nocturnal bird migration (Gauthreaux 1969), and the technique was further evaluated quantitatively in a later publication (Able and Gauthreaux 1975). Since 1969 several investigators have used the ceilometer technique (e.g., Hebrard 1971, Lindgren and Nilsson 1975, Avery, Springer, and Cassel 1976, and Balcomb 1977). In this paper I report on further developments in the basic ceilometer technique that markedly enhance its effectiveness as a research tool for studying nocturnal bird migration. These developments concern the use of an image intensifier (I^2), a low-light level closed circuit television camera (CCTV), a video tape recorder, and a high resolution television monitor.

EQUIPMENT AND METHODS

The key component to the new ceilometer technique is an image intensifier, the AN/TVS-5, manufactured by Varo, Inc., Garland, Texas (Figure 1A). This instrument is on loan from the Night Vision Laboratory of the United States Army's Electronics Command, Fort Belvoir, Virginia. The AN/TVS-5 image intensifier is a second generation device that is 32.5 cm long and weighs 3.2 kilograms. It has a resolution (lines mm^{-1}) of 56 minimum and 64 average, and amplifies ambient light 37,000 times (minumum) and 50,000 times (average). The intensifier tube diameter is 25 mm (inverter tube-military model MX-9644). The intensifier is equipped with a catadioptric objective lens (focal length 155 mm) that gives a 6.3X magnification, and the instrument has very low distortion and has reduced blooming when a bright light is in the field of view. There is a manual video gain control that regulates the amount of light amplification. The field of view is approximately 9° without the television camera. The field is reduced to a minimum of 3.1° (vertical) when displayed on the television monitor. The unit is powered by two 2.7 volt batteries. The U.S. Government price for the AN/TVS-5 is approximately $4000.

The image intensifier is coupled to a closed circuit television camera, the Hitachi HV-17LU (AC117V 60 Ha 11 watts), that has an excellent response to low light levels (Figure 1B). A Macro-Switar, *f* 1.1, 26 mm lens is attached to the CCTV camera. The quality of

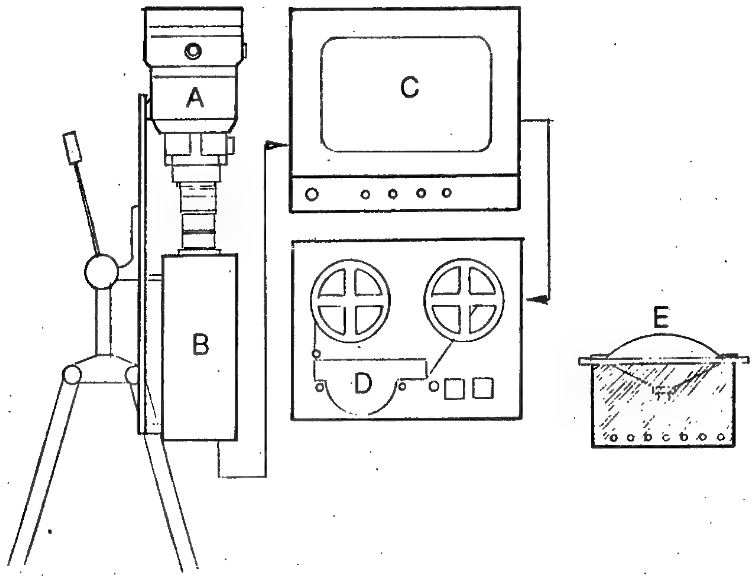


Figure 1. The image intensification-ceilometer system. A) AN/TVS image intensifier, B) video camera, C) video monitor, D) video tape recorder, E) very narrow spot light.

the image on the television monitor is adjusted by using the gain and focus on the image intensifier, the f stop and focus on the lens, and the intensity and contrast adjustments on the monitor. The monitor is a Hitachi Video Monitor, VM-126 AU (AC117V, 60 Hz, 37 watts), and has screen dimensions of 178 mm vertical and 240 mm horizontal (Figure 1C). The camera is connected to the monitor with a coaxial cable. The movements of birds aloft in the night sky can be monitored directly from the television screen or the video signal can be routed to a helical scan video tape recorder. I have used Sony AV-3600 Solid State Videocorder in my work (Figure 1D). The tape (V-30H) provides a continuous 30 minute record or a longer tape can be used for greater recording times.

Because of the cost of the ceilometer lamp bulb and transformer described in my original paper, a less expensive bulb (Sylvania 300 watt, 6.6 amp, PAR 64/3, visual approach slope indicator, mogul end prong, or the Sylvania 500 watt, PAR 64/VNSP, extended mogul end prong) is now being used (Figure 1E). These bulbs are superior to the old illumination system, because they can be used on line current

(125-160/60 AC) directly and they have higher wattage and longer life. During normal operation the vertical light beam is positioned about 20 m from the upright image intensifier. In geographical areas with sufficient ground lighting that reflects skyward (e.g., a city) the vertical light beam can be eliminated, because the undersides of the migrants aloft will receive sufficient illumination to be readily detected by the image intensifier.

On 26 occasions (10 spring, 16 fall), I was able to evaluate the performance of the image intensifier by moon watching (Lowery 1951) while gathering image intensification data. Because of the brightening of the sky when the moon in early overhead during full moon periods, comparisons were made only when the moon was between 30° and 45° elevation. However, on these occasions the sky was somewhat brighter than during other periods of the lunar cycle, and the contrast in the field of the image intensifier was reduced. When background contrast is reduced small, high-flying birds in the night sky are sometimes not detected.

RESULTS

The image intensifier-ceilometer technique readily detects even small nocturnal migrants at considerable altitudes above ground level. Although visibility tests of known birds at various distances are presently being conducted, one can get some idea of the altitude of bird targets by examining wing beat frequency, speed, brightness, and size of the image on the television screen. The depth of field at sharp focus gives additional information on the altitude of the bird. On the television screen the minimum field of view is 5.4 m at 100 m altitude, 27 m at 500 m, 54 m at 100 m, and 81 m at 1500 m.

If one compares the image intensifier-ceilometer technique with moon watching, the results suggest that the technique is about as reliable as moon watching (Figure 2). In order to compute the number of birds crossing a statute mile of front (1.609 km) per hour one must apply a correction factor of 240 to each bird crossing before the disc of the moon directly overhead. To do the same for data gathered with the image intensifier, the correction factor is about 100. Thus by using the image intensifier one can express the amount of migration in terms of a <u>migration traffic rate</u> (birds mile of front^{-1} hour^{-1}).

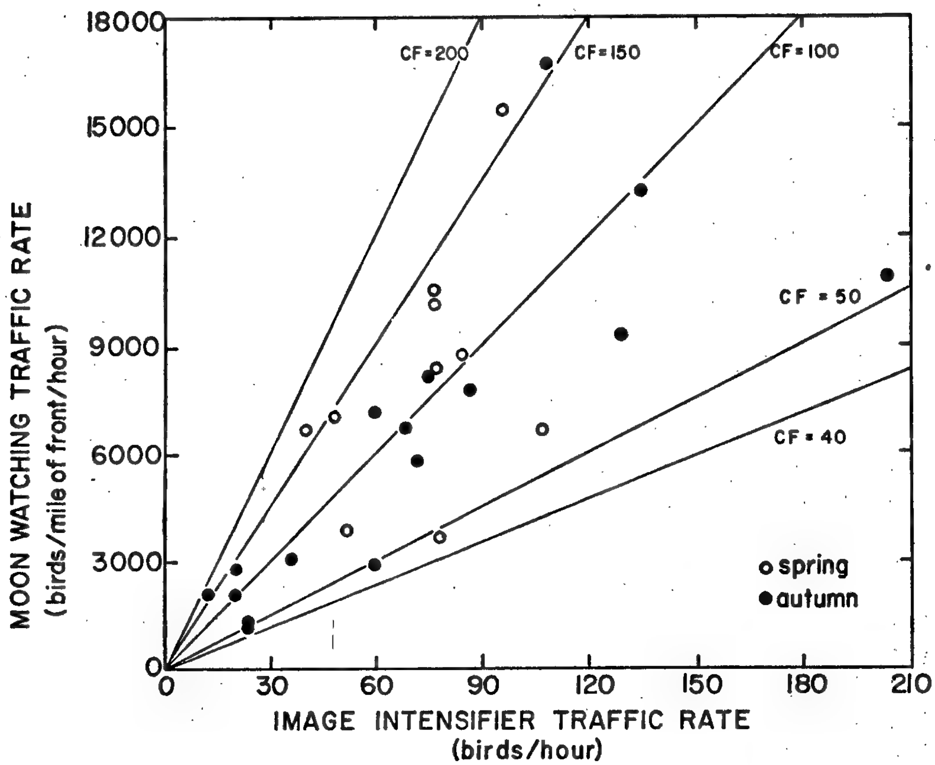


Figure 2. A graph showing the comparison of image intensifier traffic rates with simultaneous moon watching traffic rates. CF equals the correction factor applied to the image intensifier traffic rates to equal the moon watching traffic rates.

The direction of migratory movements can be determined directly from the television screen or in the event a more exact analysis is required, one can use the video tape recorder with stop action. By placing a transparent plastic sheet over the TV screen with a circle drawn so that its diameter equals the short dimension of the screen, one can use a wax pencil to precisely indicate the path of each bird. Once the sample is completed, the directions can be measured with a protractor and then statistically analyzed (Figure 3).

DISCUSSION

The use of image intensification devices is not new to zoology (e.g., Swanson and Sargeant 1972), but their application to the study of nocturnal bird migration aloft is new. The technique provides quantitative data on the number of migrants aloft and yields results

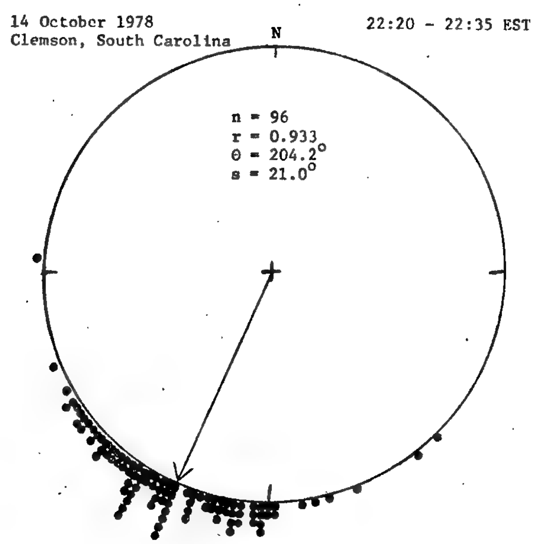


Figure 3. A plot of the flight directions of migrants aloft on 14 October 1978. n equals the number of birds, r equals the length of the resultant vector, θ equals the resultant direction, and s equals the angular deviation.

quite comparable to those obtained by moon watching (Lowery 1951). Unlike the moon watching technique, the image intensifier-ceilometer technique can be used on any night and is not dependent on the presence of the moon and the lack of cloud cover.

One disadvantage of the image intensification system is a lack of exact altitudinal information on the birds detected aloft. If the image intensifier is used in conjunction with a small vertically pointing 3 cm radar (ship board navigation radar), it should be possible to measure exactly the altitudes of the migrants detected by the image intensifier. This approach is currently being developed at Clemson University. The image intensifier-ceilometer system can also be used to monitor the behavior of birds and mammals at night. Swanson and Sargeant (1972) have used this technique to study the nocturnal feeding behavior of ducks, and there are similar applications under way by numerous investigators.

ACKNOWLEDGEMENTS

This research has been supported by a grant from the Air Force Office of Scientific Research. I thank Harry E. LeGrand Jr. for his assistance during many hours of moon watching and image intensifier-ceilometer observations. I also deeply appreciate the assistance of Donna Dixon who helped greatly with data analysis. Finally, but certainly not least, I appreciate the assistance of Sue McConnell who helped in the final preparation of this paper.

LITERATURE CITED

Able, K.P. and S.A. Gauthreaux, Jr. 1975. Quantification of nocturnal passerine migration with a portable ceilometer. Condor 77(1): 92-96.

Avery, Michael, P.F. Springer, & J.F. Cassel. 1976. The effects of a tall tower on nocturnal bird migration--a portable ceilometer study. Auk 93(2):281-291.

Balcomb, Richard. 1977. The grouping of nocturnal passerine migrants. Auk 94(3):479-488.

Gauthreaux, S.A. Jr. 1969. A portable ceilometer technique for studying low-level migration. Bird-Banding 40(4):309-320.

Hebrard, J.J. 1971. The nightly initiation of passerine migration in spring: A direct visual study. Ibis 113(1):8-17.

Lindgren, Anders & Sven G. Nilsson. 1975. Jämförelse av fyra metoder för studium av nattsträckande tattingar. [A comparison of four methods for the study of nocturnally migrating passerines.] Vår Fågelvärld 34:125-138.

Lowery, G.H., Jr. 1951. A quantitative study of the nocturnal migration of birds. University of Kansas Publication, Museum of Natural History 3:361-472.

Swanson, George A., & Alan B. Sargeant. 1972. Observation of nighttime feeding behavior of ducks. The Journal of Wildlife Management 36(3):959-961.

ADF616087

WP 9.

ON THE PREDICTABILITY OF SPRING MIGRATION OF SNOW GEESE ACROSS SOUTHERN MANITOBA, CANADA*

by

H. Blokpoel and W.J. Richardson

INTRODUCTION

The eastern population of the Lesser Snow and Blue Goose, *Anser c. caerulescens* (snow geese), winters along the coast of the Gulf of Mexico. In spring they migrate in a north-northwesterly direction through the United States and into southern Canada, where their first main migration stop-over area is located in southern-most Manitoba along the Canada/USA border (Fig. 1).

When migrating from the plains in southern Manitoba to the coasts of James and Hudson bays, the snow geese fly in north-easterly directions, often in large flocks. A good proportion of this population (estimated at 2,000,000 birds in the spring; Kerbes, 1975) crosses the Terminal Control Area of Winnipeg International Airport, an area with a radius of 56 km (30 n mi) with the centre at the airport (Fig. 1).

In spring 1969, a flock of snow geese was struck by an airliner 22 km northeast of Winnipeg. The aircraft was seriously damaged. Following this accident, the Associate Committee on Bird Hazards to Aircraft of the National Research Council of Canada was asked (1) to detect and warn of this spring migration and (2) to develop techniques to predict it.

---

*Paper presented at the 14th Annual Meeting of the Bird Strike Committee Europe, The Hague, Holland, 22-26 October 1979.

The two standard surveillance radars used for Air Traffic Control at Winnipeg International Airport and at other major airports in Canada (the AASR-1 and ASR-5) were found to detect goose flocks very well (Blokpoel, 1974). Equipment to provide bird warnings in the operational ATC environment would have to be largely automatic and be able to express the bird hazard in terms of bird strike probabilities. The prototype of a radar-based system to automatically detect and warn of migrating bird flocks has been designed and tested by Hunt (1977).

First efforts to develop techniques for predicting the annual flights of the snow geese involved the determination of (1) the usual migration chronology, and (2) the influence of the weather on amount and timing of migration. The underlying idea was that once migration patterns and the way they were affected by weather were known, density of goose migration could be predicted using the weather forecast. The first prediction model was based on (1) a rough idea of the migration chronology, and (2) the results of simple, univariate analysis of weather during 23 major goose flights known to have occurred in the period 1953-1969. This qualitative model was tested and modified using migration data for 1970-72 (obtained from radar films taken from the display of the 23-cm AASR-1 radar at Winnipeg Airport) and weather records (Blokpoel and Gauthier, 1975a). That paper discussed the feasibility of operational migration forecasts and concluded, "In summary, it seems possible to predict major waves of spring snow goose migration over the Winnipeg Terminal Control Area with reasonable accuracy and such predictions might serve to alert pilots and air traffic

controllers. It is, however, not likely that this method can be sufficiently refined to be fully satisfactory in real-time operations."

Despite these sobering concusions, the Canadian Wildlife Service, at the request of the Ministry of Transport, provided operational migration predictions at Winnipet Airport in 1974 using the revised model and locally prepared weather forecasts (Blokpoel and Gauthier, 1975b). The results were disappointing and the main problems were (1) an overly simple prediction model; (2) errors and lack of pertinent details in the weather forecasts; and (3) lack of information on the changes in distribution and numbers of staging geese as the migration season progressed. Blokpoel and Gauthier (1975b) concluded that "An improved migration prediction model with greater accuracy would only warn or alert pilots and air traffic controllers in a general way" and recommended further research and development work on a "bird/radar" (as was eventually developed by Hunt, 1977). The authors also mentioned that if migration predictions were to be made again, the prediction model would have to be improved. At the end of spring 1974 good-quality radar data were available for 4 migration seasons. This volume of data seemed large enough for multivariate analysis, as recommended by Richardson (1974). Such an analysis was subsequently carried out (Blokpoel and Richardson, 1978).

In this paper we (1) summarize the main findings of those multivariate studies of the influence of weather on snow goose migration (for details see Blokpoel and Richardson, 1978), and (2) discuss those findings in relation to the feasibility of operational goose migration predictions for ATC operations at Winnipeg International Airport.

MULTIVARIATE RELATIONSHIPS BETWEEN WEATHER AND SNOW GOOSE MIGRATION

When examining the influence of weather, we considered 25 weather variables measured at Winnipeg at the hour of peak migration in each half-day interval (0300-1500 and 1500-0300). Migration usually occurred in the morning and/or evening, reflecting the preferred take-off times of the geese (early morning and early evening). We also considered 9 weather variables measured at Pilot Mound (about 145 km southwest of Winnipeg) 2 hours before the peak hour, because most geese that flew over Winnipeg during the peak hour were believed to have departed from staging areas near Pilot Mound about 2 hours earlier (Blokpoel, 1974). The snow geese generally flew in northeasterly directions, so the following and side components of the wind were NE-SW and SE-NW, respectively.

Because migration volume was expected to change with the progression of the migration season and possibly with the time of day, we also considered temporal variables. Date and $(\text{date})^2$ were considered to account for the expected tendency of migration volume to increase, level off and then decrease as the season progressed. Period of day (0300-1500 or 1500-0300) was considered to account for possible preferences of the geese relative to the time of day.

We also considered the cumulative amount of migration during the season to date to determine whether the volume of migration could be predicted more accurately if one took account of the number of migration "waves" (major flights) of geese that had already moved over the area. As mentioned earlier, details about all variables, their scales and transformations are presented in Blokpoel and Richardson (1978).

Factor analysis, a multivariate technique, was used to reduce the large number (34) of original weather variables to a more manageable

number (8) of weather "factors". All 8 "factors" were readily interpretable: each was an index or measure of a basic characteristic of the weather. The values of the "factors" (considered as indices of various weather features) appeared likely to be useful as predictors of migration volume. The 8 weather "factors" and their simple relationships to migration volume are shown in Table 1.

The 8 weather "factors", the temporal variables and the "migration to date" variables were then used in multiple regression analysis of the migration volume during each half-day interval. Migration volume during each 12-hour period was expressed as the logarithm of the number of goose echoes observed during peak hour. The results of the regression analysis are shown in Table 2 (further details regarding the statistical procedures are in Blokpoel and Richardson (1978). As the equation in Table 2 shows, the most important predictors ($P < 0.0001$) were the following wind component "factor" and the temperature/humidity/pressure "factor". There also tended to be less migration on occasions with rain, cloudy skies and wind gusts than on fair and less windy occasions. In addition, the negative relationship to (number of preceding periods with ≥ 75 flocks in the peak hour)^2 indicated that migration volume tended to decline after several "waves" of snow geese had moved over Winnipeg. The relationship to (number of preceding periods)^2 was much more significant than that to (date)^2. This confirms the expectation that an indirect measure of the number of geese that have already moved over the Winnipeg area is a better predictor of migration volume than is date.

ACCURACY OF MIGRATION PREDICTIONS

The regression equation accounted for 67.8% of the day-to-day variance in migration volume (Table 2). Of this, 15.3% could be accounted for by consideration of temporal variables alone and 52.5% by subsequent consideration of weather "factors". A more direct indication of the forecasting ability of the regression equation may be obtained by inspection of scatter diagrams of "predicted" vs. actual migration volumes (Fig. 2). There was a strong correlation between observed and predicted migration volumes expressed on the logarithmic scale. The multiple correlation coefficient was 0.823. Of the 43 occasions when the predicted migration volume was 5 or less flocks in the peak hour, the actual migration was always less than 20 flocks and usually (35 of 43 occasions) zero; of the 31 occasions when the predicted volume was over 25 flocks, the actual volume was over 25 flocks on most (90%) occasions.

However, on a more detailed level, the predictions were not as accurate as one would wish. The predicting errors were sufficiently large that only the most extreme occasions could be distinguished with close to 100% reliability. For example, the predicted volume on the nine occasions with actual volumes of 100 or more flocks in the peak hour was usually (7 of 9 occasions) less than 60, although rarely (1 occasion) below 25. The reason for these large errors is the fact that migration volume had to be assessed on a logarithmic scale because it varied over a broad range and because of the technical requirements for the multivariate methods. Small errors in predictions of the logarithm of migration volume can represent large errors in the prediction of actual migration volume when volume is high (compare Figs. 1 and 2). The standard error of the estimates derived

from the regression equation was 0.516 on the logarithmic scale (Table 2). This means that there is a 67% probability that the actual amount of migration would be in the range 0.61-6.6 flocks per hour if a volume of 2 flocks per hour were predicted, 6.1-66 if 20 were predicted, and 61-660 if 200 were predicted. The difference between 0.6 and 6.6 flocks per hour would be of little operational importance, but that between 61 and 660 would be of considerable importance. Although the accuracy of the predictions of snow goose migration compared favourably with results obtained in other studies (cf. Richardson, 1978, p. 233), the predictions were of "order of magnitude" accuracy only.

FEASIBILITY OF OPERATIONAL GOOSE MIGRATION PREDICTIONS

Blokpoel and Gauthier (1975a, b) discussed the feasibility of operational migration predictions in general, and of spring snow goose migration over southern Manitoba in particular. As mentioned earlier the main problems with the snow goose prediction system tested in 1974 at Winnipeg International Airport were (1) an overly simple prediction model, (2) errors and lack of pertinent details in the weather forecasts, and (3) lack of information on the changes in distribution and numbers of the geese as the migration season progressed.

The prediction of migration based on simultaneous consideration of numerous weather variables is at present not feasible because the number of cases available for analysis (97) is too small to develop an optimal prediction model. Migration predictions using weather "factors" are likely to give more reliable forecasts. Table 2 shows that the regression equation using weather "factors" and temporal and "migration to date" variables

explained 67.8% of the day-to-day differences in amount of migration (52.5% being accounted for by the weather "factors", and 15.3% by the temporal and "migration to date" variables).

Although migration predictions using weather "factors" had a high degree of statistical significance, the probability of large errors was nonetheless high because of logarithmic scaling of snow goose migration volume.

Operational migration forecasts based on weather factors would add some problems to those mentioned above:

(1) Estimation of the value of each weather "factor" from observed or forecast values of the weather variables would involve a substantial amount of arithmetic and would hence require a small computer or a time-sharing computer terminal.

(2) Our analysis was based on records of the actual weather. Migration predictions would, in part, have to be based on weather forecasts, which are subject to error. Thus operational predictions would be less accurate than the above analysis suggests.

(3) The models developed here predict migration density during the peak hour of each 12-hour period. For operational purposes, some method of extrapolating those predictions to an hour-by-hour basis would be necessary.

(4) The present study confirmed the expectation that the number of birds ready to migrate with specific weather conditions is highly and negatively correlated with the numbers that have already flown overhead. The inclusion of (the number of preceding periods with ≥ 75 flocks in the peak hour)^2 in the regression equation contributed considerably to the predictability of migration volume. However, it

would be preferable to use a more refined measurement of "total migration to date" (e.g. counts of flocks detected by radar every hour) or, even better, to consider counts of geese remaining on the staging grounds. Consideration of either (or both) of these values would increase the accuracy of the prediction model, but would require considerable additional efforts to obtain the necessary data.

Because of their low accuracy and the difficulties mentioned above, migration predictions based on weather "factors" would be inadequate to serve as a useful indicator of the probability of a collision between an airliner and a flock of migrating geese; they would not be sufficiently accurate to warrant, when dense migration is predicted, such disruptive action as diversion of flights or delay of take-offs and landings. In contrast, specially designed or modified radars can be used to automatically monitor the number of flocks aloft and such numbers can be readily converted to bird strike probabilities (Blokpoel, 1976; Hunt, 1977). Although migration predictions might be useful in alerting Air Traffic Controllers and pilots in a general way, a real-time radar-based migration monitoring system appears necessary to cope effectively with the hazard caused by migrating snow geese at Winnipeg.

It does not directly follow from this conclusion that, in other circumstances, migration predictions are of little operational value. Their value may be strongly affected by the types and numbers of birds, by location, and by the type of aircraft and flight operations. In some military training programs, false "bird alarms" may be less disruptive and bird strikes may be more likely to cause serious damage or fatalities. In such cases, even an imprecise predicting capability may be useful. For

example, at Canadian Forces Base Cold Lake in east-central Alberta, routine predictions of songbird migration are made each year during spring and fall (Blokpoel, 1973). In general, however, it should be recognized that statistically significant predicting capabilities are not necessarily of operational usefulness.

REFERENCES

Bellrose, F.C. 1978. Ducks, Geese & Swans of North America. 2nd edition. Stackpole Books, Harrisburg, Pennsylvania, U.S.A., 540p.

Blokpoel, H. 1973. Bird migration forecasts for military air operations. Can. Wildlife Service Occasional Paper 16, 17p.

Blokpoel, H. 1974. Migration of Lesser Snow and Blue Geese in spring across southern Manitoba. Part 1: Distribution, chronology, directions, numbers, heights and speeds. Can. Wildlife Service Report Series 28, 29p.

Blokpoel, H. 1976. Bird Hazards to Aircraft. Clarke, Irwin and Company Ltd., Toronto. 236p.

Blokpoel, H. and M.C. Gauthier. 1975a. Migration of Lesser Snow and Blue Geese in spring across southern Manitoba. Part 2: Influence of the weather and prediction of major flights. Can. Wildlife Service Report Series 32, 28p.

Blokpoel, H. and M.C. Gauthier. 1975b. Predictions of the 1974 spring Snow Goose migration at Winnipeg International Airport. National Research Council of Canada, Associate Committee on Bird Hazards to Aircraft, Field Note 67, 31p.

Blokpoel, H. and W.J. Richardson. 1978. Weather and spring migration of snow geese across southern Manitoba. Oikos 30: 350-363.

Hunt, F.R. 1977. Automatic radar equipment to determine bird strike probability. Part II. Migrating water-fowl flocks. National Research Council of Canada, Associate Committee on Bird Hazards to Aircraft, Field Note 75, 18p.

Kerbes, R.H. 1975. The nesting population of Lesser Snow Geese in the eastern Canadian arctic: A photographic inventory of June 1973. Can. Wildlife Service Report Series 35, 46p.

Richardson, W.J. 1974. Multivariate approaches to forecasting day-to-day variations in the amount of bird migration. Proceedings of the Conference on the Biological Aspects of the Bird/Aircraft Collision Problem (S.A. Gauthreaux, Jr., ed., Clemson Univ., South Carolina, U.S.A.): 309-329.

Richardson, W.J. 1978. Timing and amount of bird migration in relation to weather: a review. Oikos 30: 224-272.

Addresses of the authors: H. Blokpoel, Canadian Wildlife Service, 1725 Woodward Drive, Ottawa, Ontario, Canada, K1G 3Z7; W.J. Richardson, LGL Ltd., environmental research associates, 44 Eglinton Ave. W., Toronto, Ontario, Canada, M4R 1A1.

TABLE 1. Weather "factors" extracted from 34 weather variables and their simple relationships to migration volume.

Weather "factor"	Product-moment correlation r	Significance level
Precipitation (Factor 1)	-0.315	0.01 > P > 0.001
Side wind component (Factor 2)	0.292	0.01 > P > 0.001
Wind speed (Factor 3)	-0.210	0.1 > P > 0.05
Following wind component Factor 4)	-0.605	P < 0.001
Temperature/Humidity/Pressure (Factor 5)	0.523	P < 0.001
Cloudiness (Factor 6)	-0.286	0.01 > P > 0.001
Gustiness (Factor 7)	-0.241	0.05 > P > 0.01
Pressure (Factor 8)	0.079	n.s.

TABLE 2. Multiple regression equation for migration volume based on stepwise analysis of weather "factors", temporal variables, and "migration volume to date" variables (N = 97)[a].

Predictor	Coefficient[b]	Standard Error	Significance Level
Day in May	0.118	0.080	n.s.
$(\text{Day in May})^2$	-0.002	0.004	n.s.
Number of preceding periods with $\geq$75 flocks in the peak hour	0.103	0.087	n.s.
$(\text{Number of preceding periods with} \geq 75 \text{ flocks in the peak hour})^2$	-0.030	0.010	$0.01 > P > 0.001$
Precipitation ("Factor" 1)	-0.193	0.060	$0.01 > P > 0.001$
Following wind component ("Factor" 4)	-0.283	0.063	$P < 0.0001$
Temp./Rel. Hum./Bar. Press. ("Factor" 5)	0.361	0.062	$P < 0.0001$
Cloudiness ("Factor" 6)	-0.148	0.064	$0.05 > P > 0.01$
Gustiness ("Factor" 7)	-0.180	0.062	$0.01 > P > 0.001$
Pressure ("Factor" 8)	0.107	0.055	$0.1 > P > 0.05$
Constant	0.189		
Multiple correlation (R)	0.823		
% variance explained ($R^2 \times 100$)	67.8		
Standard error of transformed estimate	0.516		

[a]The top 4 predictors were included in the equation regardless of significance; other predictors were excluded from the equation (and are not presented) if $P > 0.1$.

[b]Migration volume (on the logarithmic scale) = a constant (0.189) + (Day in May) x 0.118 + $(\text{Day in May})^2$ x −0.002 + ... + Pressure ("Factor" 8) x 0.107.

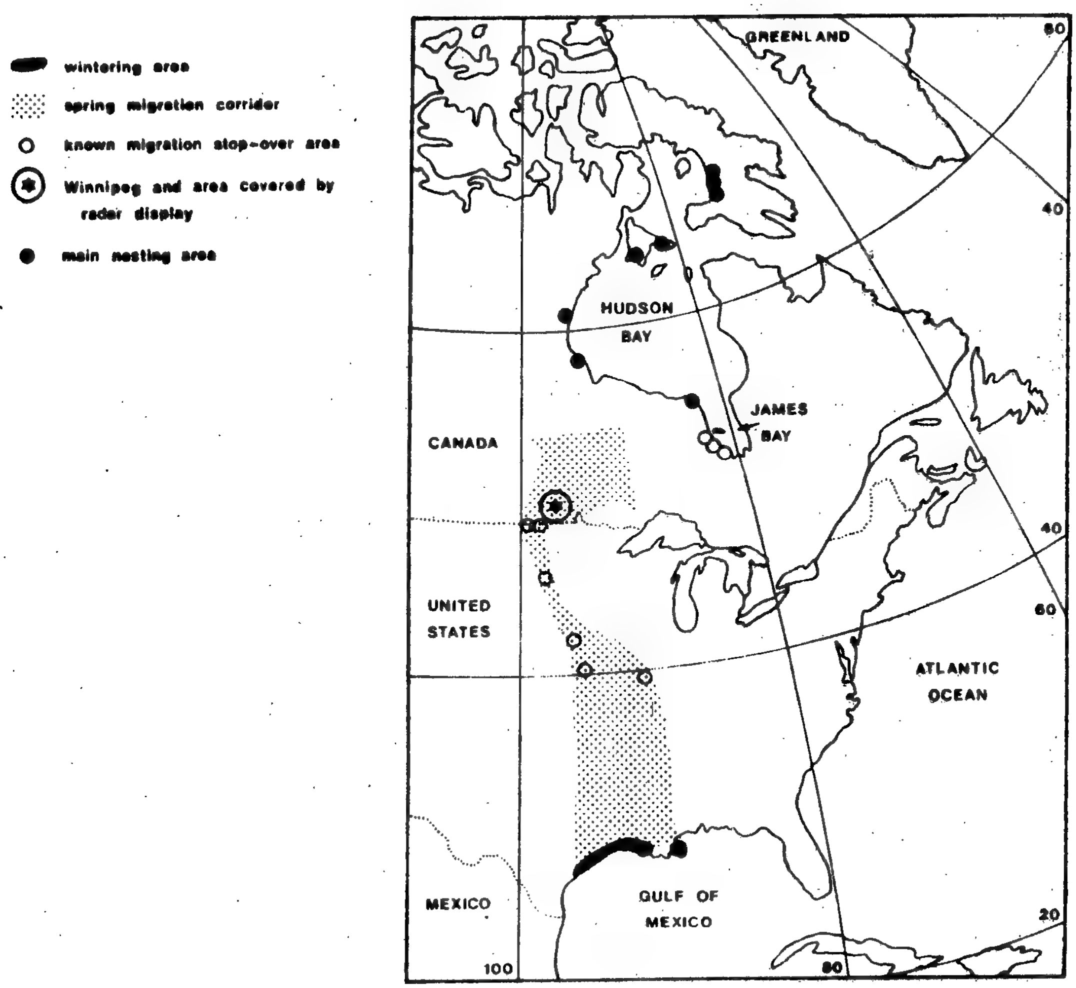


Figure 1. Range of the eastern population of snow geese (after Blokpoel, 1974 and Bellrose, 1978) and the area covered by the Winnipeg radar display used for the migration studies.

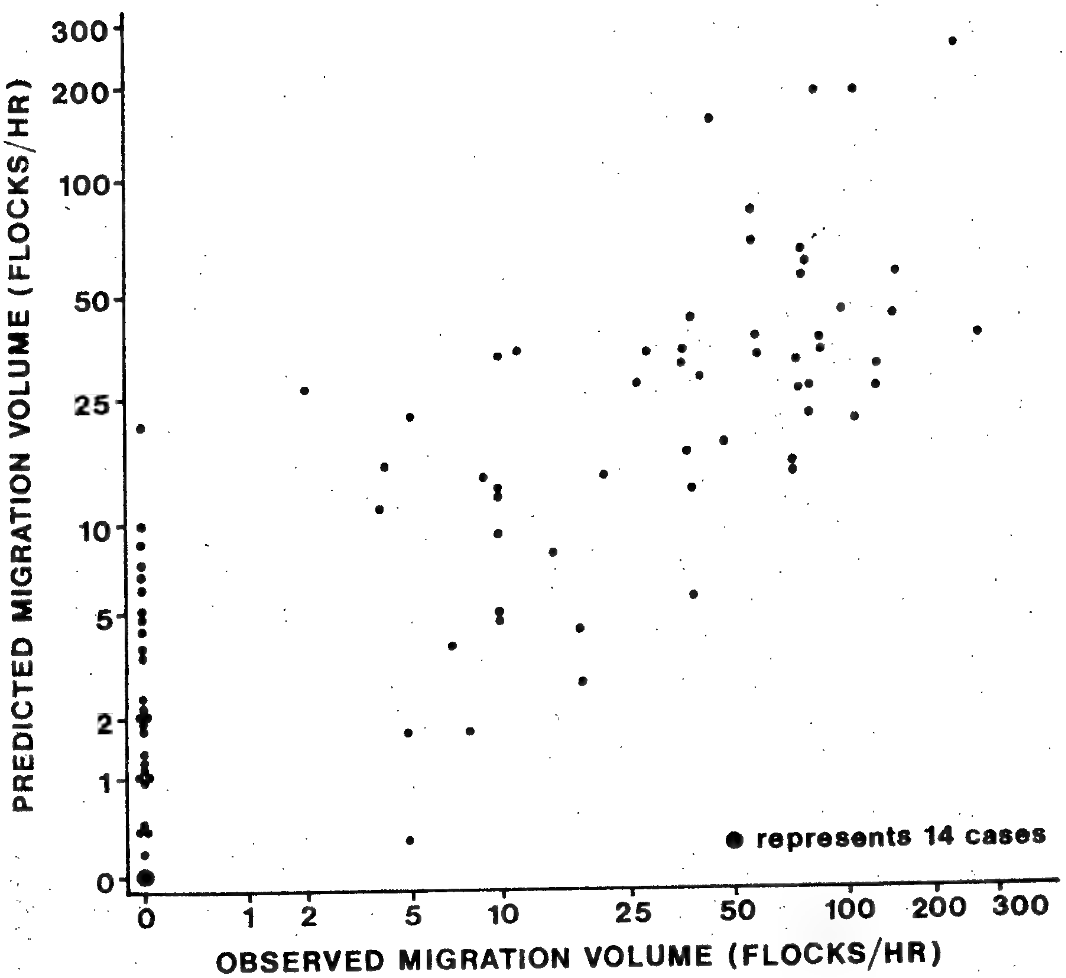


Figure 2. Migration volume predicted by the regression equation relative to observed migration volume, logarithmic scale (from Blokpoel and Richardson, 1978).

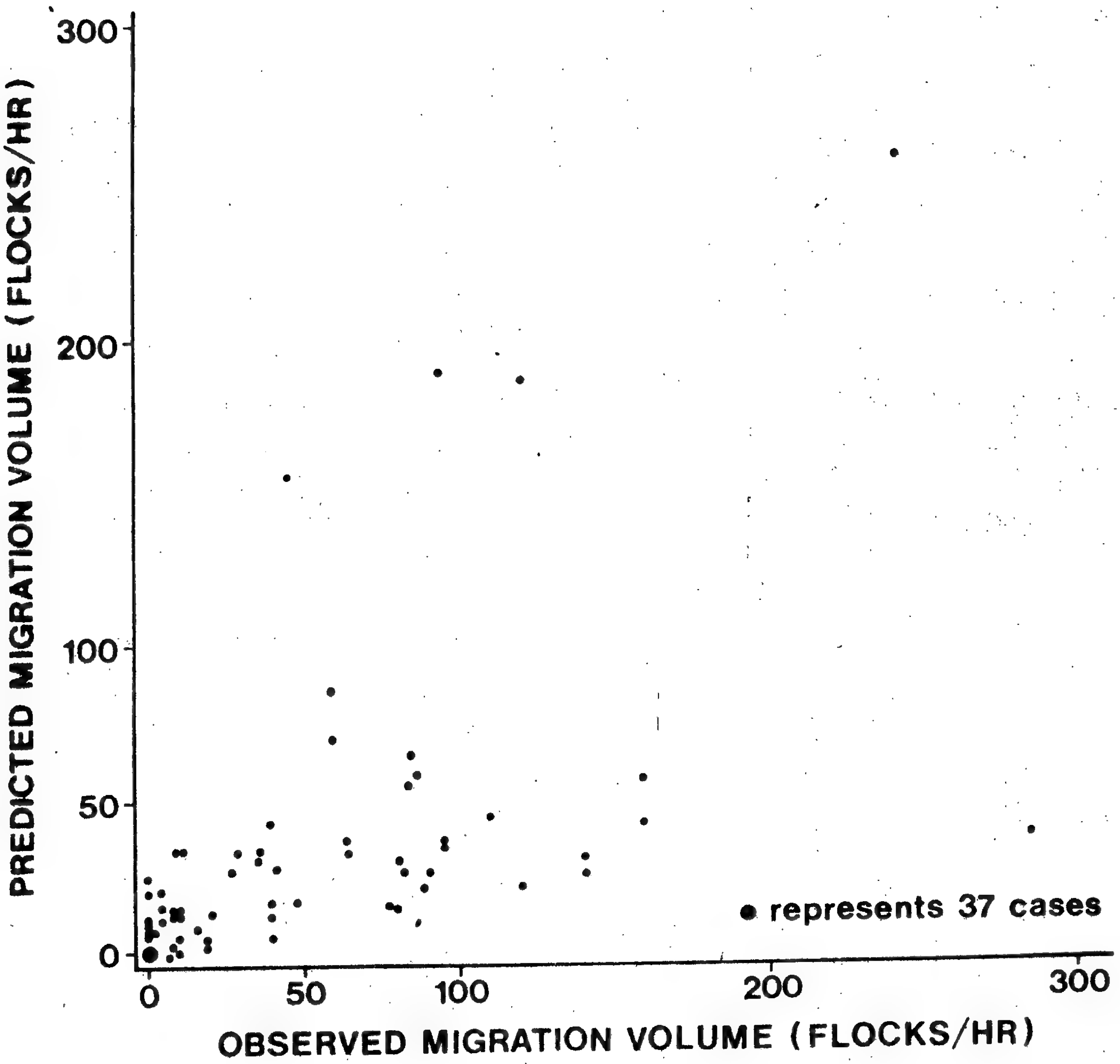


Figure 3. Migration volume predicted by the regression equation relative to observed migration volume, linear scale (from Blokpoel and Richardson, 1978).

AD F 616 088

14th Meeting Bird Strike Committee Europe
22-26 October 1979, The Hague, Netherlands

EFFECTS OF LIGHT AND LIGHT BEAMS ON BIRDS

F.J. Verheijen
Laboratory of Comparative Physiology
State University Utrecht, Netherlands

There is considerable disagreement about whether an aircraft-mounted light or a narrow beam would scare birds away, or, conversely, would attract them (Blokpoel 1976., Griffin et al. 1974, Larkin 1976, Yakobi 1978). I should like to discuss this problem with respect to midair collisions between nocturnal migrants and aircrafts. It will be suggested that the phase of the moon and the presence or absence of the moon above the horizon might well be crucial, but so far neglected, environmental variables which affect the outcome of these encounters.

The first step in any warning procedure is to attract the attention or eye of the party concerned. Light can be used for this purpose in two ways. Either a warning notice is brightly illuminated, or a warning is given by directing a bright beam towards the party concerned. In other words a warning can be given by light directed away from or, conversely, towards the party for which the message is intended.

Posters used in advertising in a sense function as "warnings". In a good advertisement the configuration should be such that the message of the poster comes over unmistakably. In behavioural terms the sign stimuli should qualitatively and quantitatively be such that they release the desired behaviour pattern.

In traffic the bright light of the headlamps of a car is in itself meaningless, but it can perform a warning function in that it appeals to the cognitive ability of man to associate the light with a specific danger, and can thus cause him to make an adequate evasive manoeuvre.

Which features of an aircraft-mounted light might signal "danger" to a nocturnal migrant bird, and thus induce an evasive manoeuvre? It is highly unlikely that a "light" conveys any configurational information to a bird. The movement of the light will neither be conspicuous to a bird which is directly in the aircraft's flight-path, because the light is coming straight towards the bird, nor will it frighten a bird by its sudden appearance because the perceived stimulus intensity increases gradually as the light approaches. Apparently, therefore, the only aspect which might determine whether a bird will be indifferent to a light, will approach it or make an evasive manoeuvre seems to be the degree to which the bird perceives the light as "uncomfortably glaring". With respect to the plausible inference that the more powerful a light the more a bird will avoid it, a word of caution: so far, very few people are aware of the tremendous orientational problems which artificial light fields may present to birds and other animals. Since animal orientation systems that use light are adapted in a highly complicated way to the spatial properties of natural light fields, these orientation systems cannot cope with some deviant properties of artificial light fields.

In my view it would be wrong to be unduly optimistic about the outcome of efforts to scare birds away by the use of artificial light. In order to get a more realistic view of the matter it would probably be helpful if I draw some distinctions between the spatial properties of natural light fields and those of artificial light fields. I shall then go on to analyse the ways in which optic orientation systems are adapted to natural light fields, and, finally, show how the unnatural spatial properties of artificial light fields may entail a disorganization of orientation.

Spatial properties of natural and artificial light fields

The angular radiance distribution (ARD)[1] at a given point in a given radiance field is obtained by making a number of measurements in various directions with a suitable detector. A three-dimensional display of the ARD, namely the radiance distribution solid (RDS) is achieved by constructing a surface through the end points of the pseudovectors, whose lengths are proportional to the radiances measured in the various directions by the rotating detector. The shape of the RDS is the result of the interactions of the radiation with the environment which either change the direction of the radiation (scattering; reflection) or decrease its intensity (absorption). Theoretically (Tyler & Preisendorfer 1962) the RDS would gradually change into either a sphere (complete isotropic radiance field) or a needle (extremely anisotropic radiance field: a parallel beam) if only scattering or only absorption were involved respectively (see Verheijen 1978, fig. 1). Because of the contributions made by the various factors that influence beam direction and intensity only a restricted group of RDS's out of the theoretical range of RDS's occurs within the habitat of a given species. I have recently proposed a vectorial measure to quantify the degree of anisotropy of a given radiance distribution: the directivity D (see Verheijen 1978). At a given point in a given radiance distribution the directivity D is determined as follows. Among all pairs of opposite irradiances E_1 and E_2 which can be measured at this point there is one pair that shows a maximum difference $E_1 - E_2$. The radiant vector $\vec{V}_R = \max(E_1 - E_2)$ quantifies the directional properties, or the degree of anisotropy, of the radiance distribution. A measure which quantifies the directional properties independently of the amount of scalar irradiance is obtained by dividing the radiant vector by the scalar irradiance. Thus the directivity $|\vec{D}| \equiv |\vec{V}_R|/E_o$ is sensitive only to the "form" of the RDS, and not to the "size". Obviously the magnitude of D ranges between zero in an isotropic radiance field and one in a parallel beam.

With the help of the directivity concept two important deviant properties of the light field produced by an artificial light source - and more particularly by a narrow beam - can be demonstrated. The reduction or the elimination of the factors influencing the direction of the rays (scattering and reflection) entails an unnaturally high directivity, and at points above the light the directivity shows, moreover, a vertical component pointing downwards, whereas in natural light fields this component generally points upwards.

Orientational adaptations to the spatial properties of natural light fields

Orientation systems based on sensitivity to radiation (light) can be roughly divided into two categories (see for instance Schwerdtfeger 1977):

1. photic systems attuned to scalar and vectorial features of the natural ARD; and
2. visual systems attuned to configurational features.

This distinction goes back to much older literature. The German biologist Precht (1942), for instance, differentiated between "Phototaxis" (reaction to "light") and "Photoentaxis" (reaction to "visible things").

Although the Bird Strike Committee is concerned primarily with birds, a comparative approach is essential because most of the available evidence relates to animals other than birds. Therefore data on invertebrates

---

[1] Because neither the spectral distribution of a radiance field nor the spectral sensitivity of an organism are taken into account in this paper it does not matter whether I use the term light or radiance.

- especially insects - and on amphibians, fish, and even man, will also be reviewed.

The nature of the two categories of orientation systems can be illustrated by the contribution that each system makes to one and the same function, namely postural control in fish. Many species of fish tend to orient their dorsal side in the "direction of the light" (von Holst 1935, 1948), as do many aquatic invertebrates and flying insects. In addition to this Dorsal Light Response (DLR) some species of fish show the Ventral Substrate Response (VSR): a tendency to orient their ventral side towards a visible substrate. The mechanism of the VSR differs from the DLR in certain important aspects, for instance the VSR is guided by configurational visual cues representing a substrate, and it operates via a higher level of neural integration than the DLR (Meyer et al. 1976). Unfortunately there are practically no data about these orientation systems in birds.

Photic systems

It must be assumed that photic orientation systems underlying the DLR are attuned to the natural shape and "upright" position of the RDS, or, in other words, to a D showing a natural magnitude and a natural upward direction. I would suggest that this explains why sardine-like fish predominantly concentrate below an underwater lamp, a fact that is of extraordinary importance in fishing techniques that use light, e.g. light-and-pump fishing (Kurc 1969, Le Men 1971, and others). Fish swimming beside the lamp and especially above it frequently behave in an agitated and capricious way, which seems to indicate that they have orientational problems. In all probability a strong DLR also accounts for the similarly aberrant behaviour of insects flying in the vicinity of a lamp. It may be for similar reasons that birds tend to congregate on dark nights below the level of lights in tall structures. Animals swimming or flying close to an artificial light frequently exhibit a lateral inward tilt because of the locally abnormal position of D. This might automatically cause the animal to circle the light, because, at least in birds and bats, a turn is typically initiated by a banked movement in accordance with the principle of the banked turn (Lighthill 1975). It is conceivable that unnaturally large differences in the excitation of the sensory elements involved in photic orientation, which are induced by a RDS that is unnatural in shape and position, will provoke aberrant orientation, i.e. disorientation, if the error signals which the moving animal uses in its feedback control mechanism (cf. Schöne 1975) acquire values that are beyond the range to which that mechanism is attuned.

Visual systems

Because visual orientation systems are attuned to configurational features the eyes must reproduce or image the environment in some detail. In general the visual world is sampled more densely in some parts of an eye than in others. For this purpose one or more regions of an eye, each termed an "area", are characterized by a relatively small angle between adjacent receptors. In birds with laterally situated eyes the central area of an eye is stimulated by stimuli in the monocular lateral visual field of that eye, and the lateral or temporal areas of both eyes are stimulated by stimuli in the common binocular frontal visual field (Meyer 1977). A similar arrangement is found in many species of fish (Ali and Anctil 1976) and insects (Horridge 1977).

Movements of one or both eyes, of the head or the whole body (depending on the degree of mobility of the eyes and the head of the animal concerned) can cause any region of the environment to be imaged on an area of the eye. A large amount of literature on this response - the "visual grasp reflex" - has accumulated. The response can be released not only by environmental visual

stimuli, but also by the electrical stimulation of structures in the central nervous system. There are indications that in the latter case the absence or presence of "appropriate sensory cues" or the "organization of the environment" determine whether the response is an isolated stereotyped output, or is part of a more complex and purposeful behaviour pattern (see for instance Phillips and Youngren 1971).

During prolonged observation of a picture, fixations of the human eye appear to concentrate on two types of regions characterized by "contrast" and by "meaning" respectively (Yarbus 1967). Engel (1976, 1977) introduced the concepts of visual and cognitive conspicuity. Eye movements to visually conspicuous contrasts can occur involuntarily, and are probably controlled at an early and low level of neural processing. Visual fixations of cognitively conspicuous configurations occur voluntarily and are probably controlled at a late and high level of neural processing. In predators visual fixation of a stimulus can lead to capture of prey or to flight. The congitive conspicuity of the stimulus - its dimensions, shape, etc. - determines which of these two behaviour patterns will be released. This has been studied extensively in toads by Ewert (1974). When there are lesions in the thalamus-pretectal region of the brain (Ewert and von Wietersheim 1974) toads are no longer able to distinguish visual patterns in a behaviourally relevant manner: prey-catching is disinhibited and occurs in answer to any visual stimulus. Obviously the key stimulus "prey" is reduced to "being visible" or "showing a contrast", or, according to the concepts of Engel (1976, 1977), to visual conspicuity.

Following bitemporal lobectomies the rhesus monkey shows as part of the Klüver-Bucy syndrome a compulsive tendency to orient visually towards and approach everything in sight (Klüver and Bucy 1939). Similar symptoms can occur in man as a result of cerebral dissolution, for instance in senility (Jackson 1884, see Ploog 1964). This apallic syndrome (Kretschmer 1940) was analysed in detail by Pilleri (1966) and more recently occurred in Japanese persons who suffered the effects of mercury poisening upon eating fish contaminated with industrial effluent (the notorious Minamata disease, see for instance Takeuchi and Eto 1976), and in Iraq among persons who had eaten wheat preserved with a mercury compound (Gerstenbrand et al. 1977).

With regard to birds, Nye (1973) found that pigeons are very skilled at responding by pecking to stimuli located in the anterior visual field but not to stimuli presented laterally. Erichsen (1977) observed, however, that Barbary doves (Streptopelia risoria) orient their head towards lighted lamps placed in various positions, fixating it monocularly with the central area of one eye. It is not clear whether these differences should be attributed to differences in the species involved, the stimuli offered, or the responses required.

The visual orientation system of a bird flying in complete darkness in the vicinity of an artificial light source might be disorganized in the following way. Because of its visual conspicuity the light source will be imaged on the area, or one of the areas, of the birds eye as a result of the orienting reflex. If the light source is imaged on the temporal area of both eyes, then the bird will fly straight towards the light source. If the light source is imaged on the central area of one eye only, e.g. the right eye, then the bird will start circling, keeping the light source to its right. Because the light source is not cognitively conspicuous, and because the dark environment does not produce cognitively conspicuous stimuli (the role of glare, which in itself is a complicated phenomenon, is not considered here) higher levels of the central nervous system that would normally decide to terminate this behaviour do not receive information about the dangerous situation. Thus the behaviour acquires a stereoptyped "forced" character such as that shown by animals during central stimulation in a "poor" environment, or by animals with central defects similar to those resulting in the apallic syndrome in man. Consequently the animal may become a victim of the trapping effect (Verheijen 1958, 1960, 1969) of the artificial light source.

The disorganization of the photic and visual orientation systems as outlined above is the result of the abnormal ARD in the vicinity of an artificial light source. Obviously moonlight reduces the abnormal character of the ARD. Thus moonlight would reduce the trapping effect of artificial light sources. There is in fact overwhelming evidence, that insects, fish and birds generally congregate at artificial lights on nights when there is a new or nearly new moon, or during periods of the night when the moon is below the horizon (Verheijen 1958, 1960, Southwood 1971, Ben Yami 1976). Recently I have considered the dates of 62 nights on which birds were reported killed at tall lighted structures in the U.S.A. between 1935 and 1973 as if they were a sample of a circular distribution of nights in a lunar month (Verheijen in prep.). The distribution proved to be non-uniform, with a highly significant clustering around the hypothetical direction, namely new moon.

Conclusions and recommendations

1. Many species of birds are attracted to artificial lights because of the "trapping effect" of this light.
2. Bird kills at tall lighted structures are correlated with two independent environmental variables: cloud cover increases the kills, whereas the presence of the moon above the horizon decreases the kills. Therefore reports of collisions between birds and aircraft and accounts of experiments designed to scare birds out of the path of an aircraft en route at night with the help of light should include data relating to the location, the date, the time, the cloud cover and the phase of the moon.
3. An aircraft-mounted narrow beam might be a more promising scaring device than the above mentioned factors underlying the trapping effect of artificial light would seem to suggest. An animal's orientation systems are only disorganized as long as they are stimulated by the unnatural light stimuli. Therefore many types of light traps are designed in such a way that the generally inevitable shadow cone occupies a minimum solid angle (insects: Southwood 1971, fish: Ben Yami 1976). A bird in the narrow collision zone in front of an approaching aircraft might move from this zone, and out of the aircraft-mounted light beam, were it to make an undirected startle response upon sudden stimulation by the narrow beam. Better still, the light beam might even induce the bird to make an evasive manoeuvre, as was suggested by Griffin et al. (1974) and Larkin (1976). I would suggest that the relations between a rigidly controlled optic stimulus situation and a bird's response could best be studied in birds trained to perform a specific task while flying in a wind tunnel.

References

Ali, M.A. & Anctil, M. (1976). Retinas of fishes. An atlas. Springer, Berlin-Heidelberg-New York.

Ben Yami, M. (1976). Fishing with light. Fishing News Books Ltd., London.

Blokpoel, H. (1976). Bird hazards to aricrafts. Books Canada Inc., Buffalo.

Engel, F.L. (1976). Visual conspicuity as an external determinant of eye movements and selective attention. Thesis Eindhoven University of Technology, The Netherlands.

Engel, F.L. (1977). Visual conspicuity, visual search and fixation tendencies of the eye. Vision Res. 17, 95-108.

Erichsen, J.T. (1977). A bird's eye view. Abstracts 15th International Ethological Conference Bielefeld, W.-Germany 23-31 August 1977. Poster Paper 53.

Ewert, J.-P. (1974). The neural basis of visually guided be[illegible] Sci. Amer. 230(3), 34-42.

Ewert, J.-P. & Wietersheim, A. von (1974). Einfluss von Thalamus/Praetectum-Defekten auf die Antwort von Tectum-Neuronen gegenüber bewegten visuellen Mustern bei der Kröte Bufo bufo (L.). J. comp. Physiol. 92, 149-160.

Gerstenbrand, F., Hamdi, T., Kothbauer, P., Rustam, H. & Al Badri, M. (1977). Apallic syndrome in chronic mercury poisoning. Eur. Neurol. 15, 249-256.

Griffin, D.R., Larkin, R.P. & Torre-Bueno, J.R. (1974). Changes in flight patterns of birds induced by searchlight beams. In: A conference on the biological aspects of the bird/aircraft collision problem (S.A. Gauthreaux, ed.), 421-427. Clemens, S.C.

Holst, E. von (1935). Über den Lichtrückenreflex bei Fischen. Publ. Staz. Zool. Napoli 15, 143-158.

Holst, E. von (1948). Quantitative Untersuchungen über Umstimmungsvorgänge im Zentralnervensystem. I. Der Einfluss des Appetits auf das Gleichgewichtsverhalten bei Pterophyllum. Z. vergl. Physiol. 31, 134-148.

Horridge, G.A. (1977). The compound eye of insects. Sci. Amer. 237(1), 108-121.

Klüver, H. & Bucy, P.C. (1939). Preliminary analysis of function of the temporal lobes in monkeys. Arch. Neurol. Psychiat. 42, 979-1000.

Kretschmer, E. (1940). Das apallische Syndrom. Z. ges. Neurol. Psychiat. 169, 576-579.

Kurc, G. (1969). L'application à la pêche des réactions phototropiques des poissons. FAO Fish. Rep. No. 62, Vol. 2, 283-296.

Larkin, R.P. (1976). The theory and practise of scaring birds away from airports and aircraft. In: Proc. Bird Hazards to Aircraft Training Seminar and Workshop (S.A. Gauthreaux, Jr., ed.), 14 pp. East Point, Georgia.

Le Men, R. (1971). Pêche électrique en mer. Science et Pêche, Bull. Inst. Pêches marit. no. 200, 16 pp.

Lighthill, J. (1975). Aerodynamic aspects of animal flight. In: Swimming and flying in nature (Th.Y.-T. Wu et al., eds.), Vol. 2, 423-491. Plenum, New York & London.

Meyer, D.B. (1977). The avian eye and its adaptations. In: Handbook of Sensory Physiology, Vol. VII/5 (F. Crescitelli, ed.), 547-611. Springer, Berlin-Heidelberg-New York.

Meyer, D.L., Heiligenberg, W. & Bullock, T.H. (1976). The ventral substrate response. A new postural control mechanism in fish. J. comp. Physiol. 109, 59-68.

Nye, P.W. (1973). On the functional differences between the frontal and lateral visual fields of the pigeon. Vision Res. 13, 559-574.

Phillips, R.E. & Youngren, O.M. (1971). Brain stimulation and species-typical behaviour: activities evoked by electrical stimulation of the brains of chickens (Gallus gallus). Anim. Behav. 19, 757-779.

Pilleri, G. (1966). The Klüver-Bucy syndrome in man. Psychiatr. Neurol. 152, 65-103.

Ploog, D. (1964). Verhaltensforschung und Psychiatrie. In: Psychiatrie der Gegenwart (H.W. Gruhle et al., eds.). Bd. I/1B, 291-443. Springer, Berlin-Göttingen-Heidelberg.

Precht, H. (1942). Das Taxis-Problem in der Zoologie. Z. wiss. Zool. 156, 1-28.

Schöne, H. (1975). Orientation in space: animals. In: Marine Ecology (O. Kinne, ed.), Vol. II, Part 2, 499-553. Wiley, London.

Schwerdtfeger, F. (1977). Ökologie der Tiere. Bd. I. Autökologie. Parey, Hamburg & Berlin.

Southwood, T.R.E. (1971). Ecological methods. Chapman & Hall, London.

Takeuchi, T. & Eto, N. (1976). Neuropathology of Minamata disease with apallic syndrome from the observation of 4 autopsy cases. Adv. Neurol. Sci. 20, 880-890.

Tyler, J.E. & Preisendorfer, R.W. (1962). Light. In: The Sea (M.N. Hill, ed.) Physical Oceanography, Vol. 1, 397-451. Interscience, London.

Verheijen, F.J. (1958). The mechanisms of the trapping effect of artificial light sources upon animals. Arch. néerl. Zool. 13, 1-107.

Verheijen, F.J. (1960). Aquarium studies: new possibilities in sardine research. Proc. World sci. Meeting Biol. Sardines (FAO, Rome), Vol. 3, 1015-1031.

Verheijen, F.J. (1969). Some aspects of the reactivity of fish to visual stimuli in the natural and in a controlled environment. FAO Fish. Rep. No. 62, Vol. 2, 417-429.

Verheijen, F.J. (1978). Orientation based on directivity, a directional parameter of the animal's photic environment. In: Animal Migration, Navigation and Homing (K. Schmidt-Koenig & W.T. Keeton, eds.), 447-458. Springer, Berlin-Heidelberg-New York.

Yakobi, V.E. (1978). Do the plane landing lights attract or scare away the birds at night? Zool. Zh. 57, 304-306.

Yarbus, A.L. (1967). Eye movements and vision. Plenum Press, New York.

AD F616 089

CONTENTS

• This study is based on information supplied and the accuracy and detail is only as good as that reported.

BIRD STRIKE COMMITTEE EUROPE

The Hague, October 1979

Ref: BSCE/14 WP 11.

BIRD STRIKES DURING 1977 TO EUROPEAN REGISTERED CIVIL AIRCRAFT
(Aircraft over 5700 kg Maximum Weight)

J Thorpe - UK
J G van Dusseldorp - Netherlands

Summary

The strikes reported throughout the World in 1977 by operators from eleven European countries have been analysed. The analysis includes rates for countries, aircraft types and aerodromes based on aircraft movements. It also covers bird species, part of aircraft struck, effect of strike, cost and airlines affected.

The strike rate in 1977 was similar to that in previous years. Gulls (Larus spp.) were involved in nearly half the incidents. The major effect was damage to 60 engines. During the year bird strikes were estimated to have cost European airlines at least 3.7 million US dollars in engineering repairs.

1. INTRODUCTION

1.1 Prior to 1972 reports containing data on bird strikes were produced by different organisations, such as airlines, aviation authorities and ornithologists. The information was presented in various forms, using different guidelines. These reports seldom contained data on aircraft movements, such that the most useful form of comparison, strike rate, could be determined.

1.2 In order that a common basis for the analysis of bird strike data could be agreed, a Working Group of the Bird Strike Committee Europe was formed in 1972, led by the representative from the United Kingdom Civil Aviation Authority Airworthiness Division at Redhill. After consultation with other member countries sets of Analysis Tables with explanatory Notes were circulated to all members of the BSCE, together with a request that each country produced an analysis on their bird strikes. These analyses were consolidated to form an annual report on Bird Strikes to European Registered Civil Aircraft, and reports covering the individual years 1972 to 1976 inclusive have been presented to annual BSCE meetings. This paper presents the 1977 analysis.

1.3 Appendix 1 contains the Tables of data relating to this paper.

1.4 Appendix 2 provides brief details of serious world-wide bird strike incidents.

1.5 Appendix 3 deals with aircraft written off due to bird strikes 1973 to 1978.

2. SCOPE

For the following reasons, the analysis includes all civil aircraft of over 5700 kg (12 500 lb) maximum weight, and executive jets which weigh just less than 5700 kg eg Lear and Citation.

(a) the airworthiness requirements relating to bird strikes are different for the smaller class of aeroplanes,

(b) much more is known about the reporting standards of operators of transport types, and their movement data is more readily available than that for air taxi or private owner aircraft,

(c) aircraft of less than 5700 kg are in general, much slower with a different mode of operation, requiring less airspace, and a noticeably different strike rate would be expected.

3. DISCUSSION

3.1 ANNUAL RATE/COUNTRY (See Table 1)

(a) Information has been obtained from a total of 11 European countries. A few of these were not able to provide full information, and their data, therefore, appears in some tables and not in others.

(b) The overall strike rate for the 1540 incidents contained in this analysis is 5.5 per 10,000 movements (two movements per flight). This is similar to the rate of 5.2 recorded during 1976.

(c) The strike rate reported by each country is dependent upon two major factors -

- reporting standard

- the bird strike problem at airports within that country, and that country's airlines route structure.

(d) The country with the highest reported strike rate is Switzerland with 9.9 per 10,000 movements, followed by the Netherlands with 9.7. France has consistently reported a rate well below average at 1.8 however this is thought to be a reporting problem.

3.2 AIRCRAFT TYPES (See Table 2)

(a) Jet Aeroplanes

(i) There appears to be no consistent correlation, between aircraft of similar design eg DC8 and B707, BAC 1-11 and DC9. It may be that aircraft which appear similar to humans are not similar to birds, and there are other factors such as noise patterns, and position of light, which affect the strike rate.

(ii) There is a distinct correlation between strike rate and aircraft frontal area although there are considerable variations between some aircraft of similar size. The most glaring discrepancy, for which no explanation has been found, is between the rates for the DC10 and L1011 Tristar. For reasons which are not clear, the DC10 rate is much greater than the L1011 Tristar reported rate.

(b) Turboprop Aeroplanes

The average strike rate for all turboprops is significantly less than that for jets.

(c) Piston Aeroplanes

Very few strikes were recorded to piston engined aeroplanes, except for the Convair 440, which has a rate of 6.7.

(d) Helicopters

The number of strikes reported to helicopters is very low, only five. Because helicopters fly mainly at low altitude where birds are most frequently found, they are continuously exposed to the risk of a strike. Therefore flying hours have been used to determine a strike rate. For reasons which are not at present known, the rate is very low at 0.5 per 10,000 hours.

3.3 AERODROMES (See Table 3)

(a) The aerodrome data is of particular importance as it may indicate where bird control measures need to be taken. Some countries were able to provide aerodrome movement data for their nationally registered aircraft, so that a national rate could be quoted.

The Total number of strikes at each aerodrome, reported by all European sources has also been included.

(b) Strikes reported on aerodromes are influenced by one or more of the following:

(i) reporting standards

(ii) the prevailing bird situation which may vary according to place and time

(iii) the number of aircraft movements

(iv) the effectiveness of bird control measures

(v) local factors perhaps beyond control of the aerodrome, eg a garbage dump or bird roost site in the vicinity.

(c) Because of factors outlined in (b), direct comparison of the reported strike rates for different aerodromes is likely to be misleading.

(d) The aerodromes with high numbers of strikes are Copenhagen, Frankfurt, Hamburg, Amsterdam, London-Heathrow and Zurich. However, most of these airports are known to have a high number of aircraft movements and a difficult bird problem but, through effective use of bird control measures, have managed to maintain a commendably low strike rate. This demonstrates what can be achieved.

(e) Significant numbers of strikes have been reported at some aerodromes outside Europe. Seventeen strikes were reported in the Bangkok area, and the numbers at Delhi, Dakar and Karachi appear to be rather high, since the number of movements by European aircraft at these aerodromes is comparatively low.

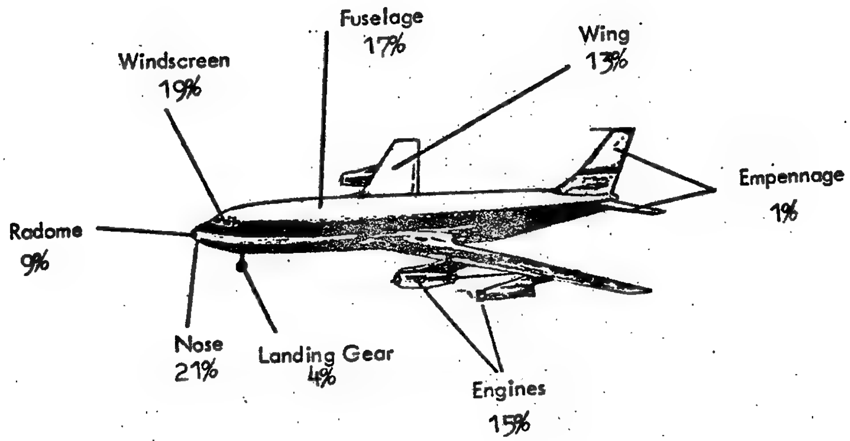
(f) There were 28 incidents where the aircraft was considered to be en-route.

3.4 BIRD SPECIES (See Table 4)

The bird species involved were identified in 770 incidents (50%). The identification standard ranged from examination of bird remains by a trained ornithologist, to the fleeting glance of a pilot. Overall 41% of strikes involved gulls (Larus sp), of which the black-headed gull (Larus ridibundus) and Common gull (Larus canus) were the most frequently identified. Next on the list were the combination of swifts, swallows and martins with 11.8% followed by Lapwings (Vanellus vanellus) with 10.2%, birds of prey at 9.3% and pigeons (Columba sp) with 9.2%. The percentage of gull and lapwing strikes was similar to the previous year. Less than 1% of incidents (6 cases) were known to involve birds of greater than 1.81 kg (4 lb).

3.5 PART OF AIRCRAFT STRUCK (See Table 5)

(a) From the figure it can be seen that the parts most frequently reported as being struck were nose with 21%, windscreen with 19%, fuselage 17% followed by engines with 15%. It should be noted that there were 11 incidents where more than one engine was struck, of which three involved all engines.



3.6 EFFECTS OF STRIKES (See Table 6)

(a) During the period covered by this paper 60 engines were damaged such as to require repair or replacement. Of these 31 were on twin-engined aircraft. It appears that 27% of engine strikes involve engine damage.

(b) Only 2 windscreens were changed, a small number when compared with 277 windscreen strikes (1%). It is thought that none of these incidents involved penetration of the windscreen.

(c) There were 8 cases of radome damage, out of 137 radome strikes, (6%). In most cases the radome was only delaminated, but in a few cases it was shattered. The radome strength is limited by the need for dielectric properties enabling satisfactory operation of the weather radar.

3.7 COST

Only three countries (Denmark, Switzerland and Sweden) have provided information on costs. From this it is estimated that the cost to all European operators is at least 3.7 million US dollars. This is the same amount estimated for the previous year.

3.8 WEATHER AND TIME OF DAY (See Table 7)

(a) It can be seen that 21% of strikes were at night. Data from Heathrow, as an example, shows that during 1978 about 20% of movements took place at night, suggesting that if Heathrow is typical, daylight or darkness appears to have little influence on bird strikes.

(b) The data about weather at the time of a strike is as yet limited, and in any case the pattern of weather, irrespective of strikes, is not easily quantified. However it can be seen that strikes associated with mist, fog and precipitation, are no greater than might be expected.

3.9 AIRCRAFT OPERATORS (See Table 8)

This table provides a guide to the reporting rates of individual airlines. It is probable that it is considerably affected by the airport(s) at which the airline has its main base.

4. CONCULSIONS

4.1 The overall rate for the 1540 strikes reported during this period by European operators is 5.5 strikes per 10,000 movements. This rate is similar to that of 5.2 for the previous year.

4.2 There does not appear, from the available data, to be any close correlation between the strike rate and the aeroplane type, in terms of speed, engine type, etc. However, despite considerable variations between types, there is a distinct correlation between strike rate and aircraft size. There is no evidence that the strike rate of executive jet aeroplanes is above that which would be expected for their frontal area. It may be that aircraft types which appear to be similar to humans are not similar to birds, and there are other factors, such as noise patterns, size, and use of lights, which affect the strike rate. The continued long term collection of statistics may provide fuller information.

4.3 There are some airports outside Europe where the number of bird strikes reported by European operators is high, but the movements by European registered aircraft are believed to be low.

4.4 Gulls (Larus sp) were struck more frequently than other birds, being involved in 40% of incidents. Less than 1% of strikes were known to involve birds of greater than 1.8 kg (4 lb). The application of measures to keep gulls away from aerodromes would do more than anything else towards minimising bird strike hazards.

4.5 It appears that the risk of a strike is similar during daylight and darkness.

4.6 The nose section including windscreen and radome were struck in 49% of incidents, followed by the fuselage with 17%. Approximately 1% of all incidents involved more than one engine.

4.7 The major effect was damage to 60 engines, approximately 1 in 4 of the engine strikes. There were also 18 cases of radome damage, approximately 1 in 20 radome strikes.

4.8 Based on information provided by three countries the estimated minimum cost of bird strikes to European airlines was at least 3.7 million US dollars in the year.

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1977

CIVIL AIRCRAFT OVER 5700 kg (12 500 lb) MAXIMUM WEIGHT

Notes: 0.1 The following are excluded from this Analysis:

(a) aircraft of maximum weight 5700 kg (12 500 lb) and under, except for those few executive jets, which have been included, eg Lear and Citation.

(b) all military type and operated aircraft.

0.2 All Tables are for strikes reported world-wide.

0.3 The Total columns of many of the Tables are different, as some countries have not been able to provide full information for every table.

0.4 There are two movements per flight.

0.5 Where the number of incidents, or number of movements are small, and particularly where they are both small, the derived rate should be treated with caution.

Table 1 National Reporting - 1977

(All airlines in each country, reporting World Wide)

Reporting Nation	Number of Incidents World Wide	Number of Movements World Wide	Rate per 10,000 Movements
Austria	9	29,600	3.0
Belgium	52	116,442	4.5
Denmark	56	168,228	3.3
Eire	22	89,570	2.5
France	93 (11)	504,750	1.8
Germany	433	477,760	9.3
Netherlands	186	190,946	9.7
Portugal	4	24,762	1.6
Sweden	72	108,617	6.80
Switzerland	184	185,338	9.9
United Kingdom	429	902,994	4.7
Total	1,540 (11)	2,799,007	5.50

Notes: 1.1 For reasons which are not apparent, there is considerable fluctuation in the movement data supplied by some countries from year to year.

1.2 Movement data for Germany is from ICAO Sources.

1.3 Helicopters are excluded from this Table.

1.4 Data from Switzerland is for Swissair only.

1.5 The figures in brackets are strikes for which no movement data is available.

1.6 Table 8 gives a breakdown by airline.

Table 2 Aircraft Type - 1977

Type	Aircraft	Number of Countries Reporting	Number of Incidents	Number of Movements	Rate per 10,000 Movements
JET					
4 engined	McDonnell Douglas DC8	6	73	77,871	9.4
	Boeing 747	8	51	71,543	7.1
	BAC VC10	1	17	24,174	7.0
	Boeing 707/720	8	117	211,450	5.5
	Concorde	2	2	3,550	5.6
	HS Comet 4	1	3	17,806	1.7
3 engined	McDonnell Douglas DC10	7	144	82,501	17.4
	HS Trident	1	92	121,598	7.6
	Boeing 727	6	193	296,808	6.5
	Lockheed 1011 Tristar	2	4	22,696	1.8
2 engined	A300B Airbus	3	37	52,816	7.0
	McDonnell Douglas DC9	6	254	385,930	6.6
	VFW 614	2	7 (1)	11,346	6.2
	Boeing 737	6	200	340,146	5.9
	Fokker F28 Fellowship	2	15	32,871	4.6
	DA01 Mercure	1	15	42,162	3.6
	BAC 1-11	3	80	254,982	3.1
	HS 125	3	10	33,808	3.0
	SE210 Caravelle	4	31	188,976	1.6
	Lear Jet	3	2	21,596	0.9
	Corvette	2	2	30,272	0.7
	Cessna 500 Citation	1	0	1,300	0
	Falcon 20	3	0 (5)	1,816	0
TURBOPROP					
4 engined	BAC Merchantman	1	8	11,954	6.7
	BAC Viscount	2	38	107,057	3.5
	Canadair CL44	1	3	9,114	3.3
	BAC Britannia	2	1	3,800	2.6
	HS Argosy	1	0	4,826	0
2 engined	Nord 262	2	4	9,662	4.1
	HP 748	1	18	44,024	4.1
	Fokker F27 Friendship	4	45	155,280	2.9
	HP Herald	1	14	66,860	2.1
	Fairchild F227	1	0	8,086	0
	DHC6 Twin Otter	2	0 (2)	3,892	0
	Beech 99	1	0 (3)	-	-

Continued overleaf

Table 2 (Continued)

Type	Aircraft	Number of Countries Reporting	Number of Incidents	Number of Movements	Rate per 10,000 Movements
PISTON					
	Convair 440	1	16	23,856	6.7
	ATL 98 Carvair	1	1	1,796	5.5
	DH114 Heron	1	1	3,030	3.3
	Douglas DC3 Dakota	1	1	16,450	0.6
	Douglas DC6	2	0	1,302	0
UNKNOWN		1	51	-	-
TOTAL			1546 (11)	2,774,245	5.6
HELI'S	Wessex 60	1	1	4,902	2.0
	Sikorsky S61	1	4	45,771	0.9
	Others	3	0	46,875	0
	TOTAL HELICOPTERS	5	5	97,548	0.5

Table 2A Summary of Aeroplane Types

	Number of Incidents	Number of Movements	Rate per 10,000 Movements
Jet	1349 (6)	2,328,018	5.8
Turboprop	131 (5)	424,555	3.1
Piston	19	46,434	4.1
Unknown	51		
TOTAL	1550 (11)	2,774,245	5.6

Notes:

2.1 Because of the low altitude of operation, and difficulty in collection of movement data, helicopter operations are quoted in hours.

2.2 The figures in brackets are for aircraft for which movement data is unavailable.

Table 3 Aerodromes - 1977

Aerodrome/Country	Incidents	Movements	Rate per 10,000 Movements	Incidents to other European Aircraft	Total Incidents
EUROPEAN AERODROMES					
Austria					
Klagenfurt	2	757	26.4		2
Linz	1	918	10.9	2	3
Salzburg	1	2,306	4.3	1	2
Vienna	2	23,630	0.8	4	6
Belgium					
Antwerp	2				2
Brussels	22			9	31
Charleroi	1				1
Ostend	3			2	5
Czechoslovakia					
Prague				2	2
Denmark					
Aalborg	1	6,895	1.4		1
Billund	2	8,707	2.3		2
Copenhagen	28	151,664	1.8	20	48
Esbjerg	6	4,650	12.9	3	9
Odense	2	3,110	6.4		2
Rønne	1	3,496	2.9		1
Skrydstrup	2	1,969	10.1		2
Tirstrup	2	4,964	4.0		2
Eire					
Cork	2			1	3
Dublin	5				5
Shannon	5			3	8
Findland					
Helsinki				3	3
France					
Bordeaux Merignac	3	10,866	2.8		3
Lyon-Satolas	7	40,156	1.7		7
Marseille	8	27,789	2.9	1	9
Mulhouse (see also Basle Switzerland)	2	4,302	4.6		2
Nice	2	23,462	0.8	2	4
Paris-Charles de Gaulle	6	61,408	1.0	11	17
Paris-Le Bourget	3	17,709	1.7	4	7
Paris-Orly	17	73,839	2.3	7	24
Strasbourg Entzheim	3	8,591	3.5		3
Toulouse Blagnac	7	15,860	4.4		7

Continued overleaf

Table 3 (Continued)

Aerodrome/Country	Incidents	Movements	Rate per 10,000 Movements	Incidents to other European Aircraft	Total Incidents
Germany					
Berlin-Tegel				2	2
Bremen	9			3	12
Cologne	16			1	17
Dusseldorf	26			11	37
Frankfurt	65			12	77
Hamburg	42			5	46
Hanover	18				18
Munich	27				27
Stuttgart	16			1	17
Gibraltar				2	2
Greece					
Athens				10	10
Hungary					
Budapest				2	2
Italy					
Genoa				2	2
Milan-Linate				16	16
Rome-Ciampino				3	3
Rome-Fiumicino				8	8
Netherlands					
Amsterdam	39	72,573	5.4	18	57
Eindhoven	1				1
Enschede	1				1
Groningen	2				2
Maastricht	4			1	5
Rotterdam	4	3,026	13.2	3	7
Norway					
Oslo-Fornebu				9	9
Stavanger				3	3
Poland					
Warsaw				3	3
Portugal					
Faro	4	8,098	4.9	2	6
Funchal	1	7,063	1.4	2	3
Lisbon	2	36,319	0.5	4	6

Continued overleaf

Table 3 (Continued)

Aerodrome/Country	Incidents	Movements	Rate per 10,000 Movements	Incidents to other European Aircraft	Total Incidents
Spain					
Barcelona				5	5
Gerona				5	5
Ibiza				5	5
Madrid				11	11
Malaga				11	11
Palma de Mallorca				5	5
Tenerife				5	5
Sweden					
Angelholm	2	3,000	6.7		2
Gothenburg-Torslanda	6	29,200	2.0	4	10
Halmstad	4	3,600	11.1		4
Karlstad	2	5,300	3.8		2
Malmo-Sturup	5	15,500	3.2	4	9
Norrkoping-Kungsangen	5	4,100	12.2		5
Umea	2	9,900	2.0		2
Vaxjo-Kronoberg	2	3,600	5.5		2
Visby	3	6,600	4.5		3
Stockholm-Arlanda	6	67,300	0.9	4	10
Stockholm-Bromma	5	30,300	1.6		5
Switzerland					
Basle (see also France)	13	9,912	13.1	1	14
Geneva	28	32,983	8.5	3	31
Zurich	46	54,442	8.4	4	50
United Kingdom					
Aberdeen	10	54,920	1.8		10
Belfast-Aldergrove	33	21,210	15.5	1	34
Birmingham	10	20,490	4.9	2	12
Blackpool	2	11,990	1.7		2
Bristol-Lulsgate	4	5,600	7.1	2	6
East Midlands	5	13,900	3.6		5
Edinburgh	22	19,500	11.3	1	23
Gatwick	27	71,980	3.7	4	31
Glamorgan Rhoose	6	6,740	8.9	1	7
Glasgow	31	30,580	10.1	2	33
Guernsey	3				3
Hatfield	2				2
Heathrow	43	121,710	3.5	9	52
Jersey	4				4
Leeds/Bradford	10	10,300	9.7	1	11
Luton	40	18,830	21.2	1	41
Manchester	5	37,300	1.3	1	6
Newcastle	3	16,220	1.8		3

Continued overleaf

Table 3 (Continued)

Aerodrome/Country	Incidents	Movements	Rate per 10,000 Movements	Incidents to other European Aircraft	Total Incidents
United Kingdom (Contd.)					
Norwich	6	13,090	4.6		6
Prestwick	18	27,360	6.6		18
Ronaldsway	9	12,950	6.9		9
Southampton	2	10,440	1.9		2
Stansted	12	13,130	9.1	2	14
Wick	2	4,100	4.9		2
Yugoslavia					
Zagreb				2	2

List of Aerodromes where more than one strike has been reported by European Operators

OTHER AERODROMES

Bangkok (Thailand)	17
Delhi (India)	11
Dakar (Senegal)	9
Karachi (Pakistan)	8
Tunis (Tunisia)	8
Tel Aviv (Israel)	7
Mombasa (Kenya)	6
Dar es Salaam (Tanzania)	6
Bombay (India)	6
Entebbe (Uganda)	4
Tokyo (Japan)	4
Accra (Ghana)	4
Lagos (Nigeria)	4
Santiago (Chile)	4
Nairobi (Kenya)	4
Freetown (Sierra Leone)	4
Khartoum (Sudan)	3
New York JFK (US)	3
Houston (US)	3
Adana (Turkey)	3
Los Angeles (US)	3
Mexico (Mexico)	3
N'Djamena (Chad)	3
Lima (Peru)	3
Kano (Nigeria)	3
Istanbul (Turkey)	3
Rio de Janeiro (Brasil)	2
Izmir (Turkey)	2
Ankara (Turkey)	2
Guayaquil (Ecuador)	2
Seychelles (Seychelles)	2
Abidjan (Ivory Coast)	2
Cairo (Egypt)	2
Colombo (Sri Lanka)	2
Douala (Cameroun)	2
Boston (US)	2
Addis Abbaba (Ethopia)	2
Monastir (Tunisia)	2
Johannesburg (S Africa)	2
Beirut (Lebanon)	2
En Route	28

Notes: 3.1 Because of variability in reporting, bird population, aircraft movement pattern, control measures and features beyond control, any comparison between the rates calculated for different aerodromes is likely to be misleading.

Table 4 Bird Species - 1977

Scientific Name	English Name	Weight/ Weight Category	Weight Category	Number of Incidents	% Based on 770
Anseriformes					
Anas platyrhynchos	Mallard	900 g	B	2	0.3
Anas sp.	Duck	300-1.5 kg	B	2	0.3
Anser sp.	Goose	up to 2.5 kg	C	1	-
Apodiformes					
Apus apus	Swift	30 g	A	19	2.5
Charadriiformes					
Charadrius hiaticula	Ringed Plover	55 g	A	2	0.3
Pluvialis apricarius	Golden Plover	200 g	B	7	0.9
Vanellus vanellus	Lapwing	250 g	B	79	10.3
Haematopus ostralegus	Oyster catcher	550 g	B	6	0.8
Larus argentatus	Herring gull	1.1 kg	B	9	1.2
Larus canus	Common gull	400 g	B	9	1.2
Larus fuscus	Lesser black-backed gull	800 g	B	2	0.3
Larus marinus	Great black-backed gull	1.8 kg	B	1	-
Larus ridibundus	Black headed gull	300 g	B	62	8.0
Larus sp.	Gull	300-1.8 kg	B	227	29.5
Sterna hirundo	Common Tern	200 g	B	4	0.5
Otis tarda	Great Bustard	5-10 kg	D	1	-
Calidris sp.	Sandpiper	100 g	A	1	-
Numenius arquata	Curlew	800 g	B	3	0.4
Ciconiiformes					
Ardea cinerea	Grey Heron	up to 1.8 kg	B	3	0.4
Ciconia sp.	Stork	up to 3 kg	C	1	-
Columbiformes					
Columba livia	Rock dove	250 g	B	6	0.8
Columba oenas	Stock dove	250 g	B	8	1.0
Columba palumbus	Woodpigeon	450 g	B	11	1.4
Columba sp.	Pigeon	450 g	B	45	5.8
Streptopelia turtur	Turtle dove	155 g	B	1	-
Falconiformes					
Accipiter gentilis	Goshawk	1.0 kg	B	4	0.5
Buteo buteo	Common Buzzard	880 g	B	1	-
Buteo sp.	Buzzard	up to 880 g	B	27	3.5
Milvus migrans	Black Kite	1.0 kg	B	3	0.4
-	Vulture	up to 5 kg	C	1	-
Milvus milvus	Kite	1.0 kg	B	3	0.4
Falconidae					
Falco sp.	Falcon	up to 800 g	B	27	3.5
Falco tinnunculus	Kestrel	200 gr	B	6	0.8

Continued overleaf

Table 4 Bird Species - 1977 (Contd.)

Scientific Name	English Name	Weight/ Weight Category	Weight Category	Number of Incidents	% Based on 770
Galliformes					
Alectoris rufa	Red-legged partridge	420 g	B	1	-
Perdix perdix	Partridge	300-400 g	B	14	1.8
Phasianus colchicus	Pheasant	1.2 kg	B	5	0.6
Gruiformes					
Grus grus	Crane	4-12 kg	D	1	-
Passeriformes					
Corvus corax	Raven	1.2 kg	B	1	-
Corvus corone corone	Carrion Crow	550 g	B	8	1.0
Corvus monedula	Jackdaw	230 g	B	1	-
Pica pica	Magpie	220 g	B	3	0.4
Corvus sp.	Crow	550 g	B	4	0.5
Passer domesticus	Sparrow	18-40 g	A	27	3.5
Alauda arvensis	Skylark	40 g	A	8	1.0
Hirundo rustica	Swallow	15 g	A	72	9.3
Anthus pratensis	Meadow pipit	18 g	A	1	-
Sturnus vulgaris	Starling	85 g	A	22	2.9
Turdus merula	Blackbird	95 g	A	5	0.6
Turdus viscivorous	Mistle Thrush	120 g	B	1	-
Turdus pilaris	Fieldfaire	100 g	A	1	-
Turdus sp.	Thrush	100 g	A	1	-
Pelecaniformes					
Sula Bassana	Gannet	2.5 kg	C	1	-
Strigiformes					
Athene noctua	Little owl	100 g	A	1	-
Surnia ulula	Hawk owl	300 g	B	1	-
Tyto alba	Barn owl	200 g	B	1	-
-	Owl	170-380 g	B	4	0.5
Unknown				787	
TOTAL				1557	100%

Notes:

4.1 Bird weights and Scientific Names are based on information supplied by Aviation Unit, Worplesdon Laboratory, Agricultural Science Service, MAFF, Worplesdon, England and the average weight has been assumed.

4.2 The bird Categories based on current Civil Airworthiness requirements are:

A below 110 g ($\frac{1}{4}$ lb)
B 110 g to 1.81 kg ($\frac{1}{4}$ lb to 4lb)
C over 1.81 kg to 3.63 kg (4 lb to 8 lb)
D over 3.63 kg (8 lb)

4.3 Those birds not positively identified are tabled as Unknown. except where there is evidence that they are Large (C or D).

4.4 Percentages are based on incidents where birds are identified.

Table 5   Part of Aircraft Struck - 1977

PART STRUCK	Number of Strikes by Bird Weight Category					% Based on 1490
	Unknown	A	B	C&D	Total	
Fuselage	120	34	96	2	252	16.9
Nose (excluding radome and windscreen)	164	49	105	-	318	21.3
Radome	80	15	42	-	137	9.2
Windscreen	156	50	70	1	277	18.6
Propeller	3	2	12	-	17	1.1
1 engine struck	109	10	7	1	207	13.9
2 out of 3 struck	1	-	1	-	2	0.
2 or more of 4 struck	1	1	4	-	6	0.4
all engines struck	-	-	3	-	3	0.2
Wing/Rotor	93	16	85	-	194	13.0
Landing Gear	22	6	38	1	67	4.5
Empennage	1	2	7	-	10	0.7
Part Unknown	46	21	122	-	189	
TOTAL	796	206	672	5	1,679	99.97%

Notes: 5.1 The totals in Table 5 are higher than other tables, as several parts can be struck in one incident.

5.2 The percentages are based on incidents where the part struck is known.

5.3 Where both landing gear, or both wings are struck, two incidents are recorded.

Table 6 **Effect of Strike - 1977**

EFFECT	Number of Strikes by Bird Weight Category						% Based on 627
	Unknown	A	B	C	D	Total	
Loss of life/aircraft	-	-	-	-	-	-	-
Flight Crew Injured	-	-	-	-	-	-	-
Engine damage requiring repair on:-							
2 engined aircraft	10	1	20	-	-	31	5.0
others	20	-	9	-	-	29	4.6
Windscreen cracked or broken	-	-	1	1	-	2	0.3
Vision obscured	1	-	1	-	-	2	0.3
Radome changed	4	-	4	-	-	8	1.3
Deformed structure	1	-	8	-	-	9	1.4
Skin torn/light glass broken	2	-	6	-	-	8	1.3
Skin dented	15	-	23	1	-	39	6.2
Propeller/Rotor/transmission damaged	-	-	-	-	-	-	-
Aircraft system lost	2	-	10	-	-	12	1.9
Take off aborted	1	-	3	-	-	4	0.6
Nil damage	258	81	142	1	1	483	77.0
Unknown	23	20	43	-	-	86	-
TOTAL	337	102	270	3	1	713	100.01%

Notes: 6.1 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

6.2 The percentages are based on known effects.

Table 7 Weather - Strikes on or Near Aerodrome

Weather Condition / Time of Day	Dawn		Day		Dusk		Night	
Precipitation	1		9		1		1	
Mist/Fog*	1		7		1		-	
Cloud: +	< ½	> ½	< ½	> ½	< ½	> ½	< ½	> ½
base below 1000 ft	-	-	-	5	-	-	-	1
base 1000 - 5000 ft	3	1	19	7	1	1	4	3
above 5000 ft	-	-	5	16	1	-	1	8
Base Unknown	2	6	58	61	-	1	13	12
Clear	6		113		12		40	
Unknown	1		35		2		18	
Total in each time band	21		335		20		101	
% in each time band	4.4		70.2		4.4		21.2	

Notes: 7.1* Visibility less than 1000 metres.

7.2+ Cloud cover less than half ie 1 to 4 octas.

7.3+ Cloud cover more than half ie 5 to 8 octas.

7.4 Clear includes CAVOK.

Table 8 Aircraft Operators Reporting Strikes - 1977

Operator	Number of Incidents	Number of Movements	Rate per 10,000 Movements
Austria			
Austrian Airlines	9	28,000	3.2
Belgium			
Sabena	50	87,864	5.7
Young Air Cargo	2	2,888	6.9
Others	0	25,690	0
Denmark			
Conair	14	5,928	23.6
Cimber Air	7	14,574	4.8
Maersk Air	2	15,610	1.3
SAS	25	89,516	2.8
Sterling Airways	4	40,142	1.0
Others & Unknown	4	31,136	-
Eire			
Aer Lingus	22	89,570	2.5
France			
Air Alpes	2	70,000*	0.3
Air France	24	350,000	0.7
Air Inter	48	143,642	3.3
Euralair	1	126,406	0.1
TAT	3	66,970	0.4
UTA	15	29,500*	5.1
Others	11	-	-
Germany			
Lufthansa	388	364,036	10.7
Others	55	113,724	4.8
Netherlands			
All Operators	186	190,946	9.7
Portugal TAP	4	24,762	1.6
Sweden			
Linjeflyg AB	30	48,727	6.2
SAS	40	164,182	2.4
Others	4	6,929	-

Continued overleaf

Table 8 Contd.

Operator	Number of Incidents	Number of Movements	Rate per 10,000 Movements
Switzerland			
Swissair	184	185,338	9.9
United Kingdom			
Air Anglia	14	30,540	4.6
Bristow Helicopters	2	68,690	0.3
Britannia Airways	25	43,620	5.7
British Air Ferries	6	20,440	2.9
British Airways			
Overseas	38	81,780	4.6
Remainder	183	387,990	4.7
British Caledonian	27	75,930	3.5
British Island	9	48,210	1.9
British Midland	14	43,100	3.2
Dan Air	20	103,990	1.9
IAS Air Cargo	3	4,510	6.6
Laker	5	18,970	2.6
McAlpine	3	6,500	4.6
Monarch	13	15,530	8.4
Transmeridian	4	5,454	7.3
Others & Unknown	66	-	-

Notes: 8.1 *Estimated movements
8.2 Leased aircraft are included against the operator

SERIOUS BIRD STRIKE INCIDENTS WORLD-WIDE OPERATORS - 1977
(Aircraft Over 5700kg and Executive Jets)

1. 14 January 1977 KLM DC8-63 at Amsterdam, Netherlands

At 160 kts on take off struck flock of gulls (Larus spp). Engine 2 was shutdown, fuel jettisoned and aircraft returned. Engines 1 and 2 were damaged.
(Source - Netherlands Reporting System).

2. 3 July 1977 Transport Lockheed 188 Electra (location unknown)

Engine 2 suffered bird strike prior to landing, shutdown. During subsequent inspection found engine 3 also damaged. Both engines changed.
(Source - US FAA Service Difficulty Reports)

3. 5 August 1977 Linjeflyg Convair 440 near Oernskoeldsvik, Sweden

At approximately 1700ft during the descent at 240 kts the aircraft struck a buzzard (Buteo sp). A hole about 8 inches wide was made in the wing leading edge just outboard of the engine.
(Source - Swedish Reporting System).

4. 9 August 1977 TWA B707 at San Francisco, US

Struck birds on take off No 1 engine stalled, aircraft returned. Found engine 1 compressor damaged, and engine 4 fan blades damaged. Engine 1 changed, No 4 fan damage dressed out.
(Source - US FAA Service Difficulty Reports).

5. 14 August 1977 Dan Air Comet between Birmingham UK and Venice, Italy

Found on arrival that engines 1 and 4 were damaged such as to require replacement. No birds seen en-route and no sign of problems from engine indications.
(Source - UK Reporting System).

6. 16 August, 1977 Private Learjet 24 at Baton Rouge, USA

When near rotation during a dusk take-off, the aircraft struck a large flock of birds. Birds were ingested into the left engine which flamed out. The take-off was abandoned, but the aircraft overran the wet 6900ft long runway, and was substantially damaged when it collided with a ditch. There were no injuries to the 8 occupants.
(Source - ICAO ADREP Report 2/78 No 6).

7. 15 September 1977 B737 near Honolulu, US

Aircraft was three miles from the outer marker at 240 kts, and had just broken out of the overcast when a large black bird thought to be a frigate (Fregata sp) appeared in front of the aircraft. The First Officer was flying the aircraft, the Captain shouted a warning, but the bird struck the First Officer's windscreen, completely shattering all panes. Both crew members were covered with broken glass, the screen bowed in, but did not fail completely. The Captain landed the aircraft.
(Source - Flight Safety Foundation).

8. <u>3 November 1977 United Airlines B747 at Newark Airport New York</u>

Bird strike just after take off on engine 3, followed by power loss and vibration. Engine was shutdown. One fan blade had detached and made 7 x $8\frac{1}{2}$ inch hole in nose cowl, extensive LP and HP compressor damage. Bird believed to be gull (Larus spp). (Source - US FAA Service Difficulty Reports).

9. <u>Date Unknown in 1977 B747SP at Tokyo, Haneda, Japan</u>

At approximately 2700ft several sharp explosions and airframe jolts were heard. Flames in vicinity of engine 1 were observed by the Captain as birds had been ingested through the engine. He shutdown No 1 engine, at the same time as the Flight Engineer observed a rapidly climbing EGT on engine No 2, and shut it down as the EGT reached 920^{o}. The aircraft continued to climb (TOW was 523,3000lbs) and was passing 3800ft at 220 kts when a return was requested from ATC. An attempt was made to start No 2 engine, but was abandoned when the N2 was seen to be zero. No 1 engine was restarted but cabin crew reported smoke in the cabin and the engine was again shutdown when the EGT was increasing rapidly beyond 700^{o}. The aircraft landed 13 minutes after take off 70,000lbs above maximum landing weight. The No 2 engine failure was caused by a bearing failure, but no fault was found in No 1 engine. (Source - Air Safety from Pakistani International Airlines).

AIRCRAFT WRITTEN OFF DUE TO BIRD STRIKES
(World Wide Operators)

	Civil Aircraft Over 5700kg & Exec Jets	Others Civil Aircraft
1973	2	-
1974	1	-
1975	3	-
1976	2	-
1977	0	1
1978 (Provisional)	2	4

Note: 1977 is the first year for five years without a large aircraft being written off as a result of a bird strike. However, two aircraft were written off in 1978.

BIRD STRIKE COMMITTEE EUROPE
ANALYSIS WORKING GROUP

ACCIDENTS AND SERIOUS INCIDENTS TO TRANSPORT AIRCRAFT
Aircraft over 5700kg (12500 lbs) and Executive Jets

Date	Aircraft	Regn.	Operator	Location	Nature of Flight	Total Aboard		Injury to Occupants F	S	M/N	Damage to Aircraft
12.12.47	DC3	VH-BFW	Mandated	India/ Australia		?	Crew	0	0	?	Substantial
							Pass	0	0	?	

During a flight from India to Australia the aircraft suffered damage to the starboard wing as the result of inflight collision with a vulture.

22.1.49	CV240		American	Near Columbus, Ohio	Scheduled Passenger	28	Crew	0	0	3	Substantial
							Pass.	0	0	25	

Struck a small duck while in flight. Landed safely.

23.9.50	DC6	SE-BDO	SAS	Calcutta	Scheduled Passenger	37	Crew	0	0	10	Substantial
							Pass.	0	0	27	

Substantially damaged after colliding with a vulture shortly after takeoff. There were no casualties amongst the 27 passengers and 10 crew on board.

6.11.51	DC4		National	Near New York	Non Revenue	3	Crew	0	0	3	Substantial
							Pass.	0	0	0	

While descending on an approach to the airport, the aircraft struck two seagulls at 1500 feet altitude.

1.2.52	DC3	AP-ABC	Orient Airways	Tejgaon Airport	Scheduled Passenger	?	Crew	0	0	?	Substantial
							Pass.	0	0	?	

Sustained considerable damage to the front windscreen and nose after colliding with a vulture shortly after takeoff. The pilot was slightly injured.

16.5.53	DC3D	N-37469	Pacific Northern	Anchorage, Alaska	Passenger	12	Crew	0	0	3	Substantial
							Pass.	0	0	9	

Aircraft encountered a flock of ducks in flight, damaging leading edge of wing.

16.9.54	DC3	XY-ADD	UAB	30 miles from Calcutta	Scheduled Passenger	24	Crew	0	1	1	Substantial
							Pass.	0	0	21	

During flight two vultures struck the aircraft, smashed the windscreen, and landed in the cockpit. The pilot and radio officer were injured. A safe landing was made. There were 21 passengers and 3 crew on board. No other injuries.

2.4.55	Viking	ZS-DKI	Trek Airways	Messina, Transvaal	Passenger	32	Crew	0	0	5	Substantial
							Pass.	0	0	27	

During a flight to Johannesburg the aircraft collided with a bird causing damage to the starboard wing. An emergency landing was made at Messina. No injuries to the 27 passengers and 5 crew.

19.10.55	Dakota	AP-AAC	PIA	Tezgaon, Near Dacca	Passenger	?	Crew	0	0	?	Substantial
							Pass.	0	0	?	

Shortly after takeoff the aircraft was hit by a vulture which badly damaged the starboard wing. A safe landing was made and there were no injuries to passengers and crew.

25.10.56	CV240	N94214	American	Fort Worth, Texas	Scheduled Passenger	44	Crew	0	0	4	Substantial
							Pass.	0	0	40	

While cruising at 4,000 feet the crew felt a hard thud in the floor under their feet. On the landing approach, the nose gear could not be extended and a landing was made with it retracted. Evidence indicated that a large bird had collided with the airplane, damaging the left nose gear door and preventing wheel extension.

13.3.59	DC3		Ozark	St. Louis, Missouri	Scheduled Passenger	15	Crew	0	1	2	Minor
							Pass.	0	0	12	

While in normal cruise at an altitude of 3,300 feet, IAS 140 knots, the aircraft collided with a small duck which penetrated the sliding window located on the left side of the cockpit. The Captain was seriously injured about his face and eyes. The flight returned to its point of takeoff and landed safely.

Date	Aircraft	Regn.	Operator	Location	Nature of Flight	Total Aboard		Injury to Occupants F	S	M/N	Damage to Aircraft
22.5.59	DC3	D-CADE	Deutsche Lufthansa	London		2	Crew	0	0	2	Substantial
							Pass.	0	0	0	

During takeoff for a flight to Dusseldorf the aircraft collided with birds. The nose section was dented and the windscreen broken. There were 2 crew on board, no injuries.

24.6.59	Douglas			Medellin Airport, Columbia		?	Crew	0	0	?	Substantial
							Pass.	0	0	?	

Shortly after takeoff a four-engined Douglas aircraft collided with a vulture. The impact made a deep hole in the wing tank causing a heavy loss of petrol. The aircraft returned and landed safely back at Medellin Airport. No injuries to the occupants.

4.10.60	Lockheed L-188	N-5533	Eastern	Boston, Mass.	Scheduled Passenger	72	Crew	3	1	1	Destroyed
							Pass.	59	8	0	

A few seconds after becoming airborne, the aircraft struck a flock of starlings. A number of these birds were ingested in engine No. 1, 2 and 4. Engine No. 1 was shut down and its propeller was feathered. Nos. 2 and 4 experienced a substantial momentary loss of power. This abrupt and intermittent loss of recovery of power resulted in the aircraft yawing to the left and decelerating to the stall speed. As speed decayed during the continued yaw and skidding left turn, the stall speed was reached; the left wing dropped, the nose pitched up, and the aircraft rolled left into a spin and fell almost vertically into the water. As altitude of less than 150 feet precluded recovery.

Probable Cause: The Board determines that the probable cause of this accident was the unique and critical sequence of the loss and recovery of engine power following bird ingestion, resulting in loss of airspeed and control during takeoff.

9.3.61	DC6	N-37530	United	Near Elgin, Ill.	Scheduled Passenger	46	Crew	0	0	5	Substantial
							Pass.	0	0	41	

During climb from 4,000 to 5,000 feet following takeoff from O'Hare Field, the aircraft struck four geese. Two struck the plane glancing blows and caused little damage; however, the others hit the plane directly and caused substantial aircraft damage and a potentially serious situation. One shattered the co-pilot's windshield but did not penetrate it. The other penetrated the nose section of the plane at fuselage station 47, and penetrated the pressure bulkhead at station 64 causing immediate depressurisation. Damage to instrument static and pressure lines affected the Captain's flight instruments. Seriously hampered by obstructed visibility, the pilots landed the plane without further incident.

Probable Cause: In-flight bird strike.

15.7.62	DC3	VT-AUS	Indian Airlines	Near Lahore, West Pakistan	Non Scheduled Freight	3	Crew	1	0	2	Minor
							Pass.	0	0	0	

While operating a freight service from Kabul to Amritsar the aircraft was struck by a vulture near Lahore. The windscreen was smashed and the co-pilot was fatally injured.

11.9.62	Vanguard 953	G-APET	BEAC	Edinburgh Airport	Scheduled Passenger	76	Crew	0	0	8	Substantial
							Pass.	0	0	68	

During a takeoff from runway 13 at night, in conditions of low cloud and heavy rain, the aircraft flew through a flock of gulls immediately after leaving the ground. Large numbers of birds struck the aircraft and forward vision was obliterated. No. 4 engine failed almost immediately and the other three engines were also effected. The climb was continued on the power available in order to position the aircraft for an ILS approach. At 3,800 ft. No. 2 engine failed and the propeller was feathered. The stage of No. 3 engine also became critical and preparations were made for an emergency landing, but after an ILS approach, a successful landing was made on runway 13. When the aircraft returned to the apron 30 minutes after departure it was found to be severely damaged and oil coolers and engine cowlings were seen to be almost blocked with dead birds.

24.10.62	Convair 340	N-90857	North Central	Pierre, South Dakota	Scheduled Passenger	47	Crew	0	0	3	Substantia
							Pass.	0	0	44	

About 35 miles northeast of Pierre, South Dakota, the aircraft sustained multiple bird strikes, two of which caused penetration of the right wing structure of the aircraft. The occurrence was at night while the flight was cruising at an indicated altitude of 4,500 feet m.s.l., in VFR conditions. Although the right wing sustained appreciable damage externally and internally in the areas of penetrations, no adverse flight characteristics resulted, and the pilot continued the flight to destination without further incident. Inspection revealed that the aircraft had encountered a flock of wild geese, at least four of which had struck the aircraft. The two which penetrated the wing weighed about 14 pounds each. One penetrated into a fuel cell of the right wing, another to a depth of 18 inches in the right wing tip cap.

Probable Cause: In-flight bird strike during cruising flight at night.

Date	Aircraft	Regn.	Operator	Location	Nature of Flight	Total Aboard		Injury to Occupants F	S	M/N	Damage to aircraft
23.11.62	Viscount 745	N-7430	United	Ellicott City, Maryland	Scheduled Passenger	17	Crew	4	0	0	Destroyed
							Pass.	13	0	0	

En route from Newark N.J. to Washington, D.C. at an assigned altitude of 6,000 ft., the aircraft penetrated a flock of whistling swans, at least two of which were struck by the aircraft. One swan, which was struck penetrated the leading edge of the left horizontal stabilizer and egressed from the rear surface causing damage to the elevator as it did so. This so weakened the structure that failure occurred which rendered the aircraft uncontrollable. Thereafter, N-7430 descended and struck the ground in a nose-low inverted attitude.

Probable Cause: The Board determines that the probable cause of this accident was a loss of control following separation of the left horizontal stabilizer which had been weakened by a collision with a whistling swan.

6.12.62	C54A	5N-AFC	Pan African	Kano, Nigeria		?	Crew	0	0	?	Substantial
							Pass.	0	0	?	

Shortly after takeoff from Kano the aircraft was in collision with a bird. The bird penetrated the leading edge of the port wing No. 1 fuel tank. A safe landing was made at Kano. No injuries to the occupants.

22.9.65.	Douglas DC-6B	N-3759	UAL	Nr. Des Moines, Iowa.	Scheduled Passenger	74	Crew	0	1	4	Substantial
							Pass.	0	0	69	

In clear night weather conditions, at 2235, the Captain of Flight 551, Norfolk, Va. to Des Moines, Iowa, cancelled his IFR flight plan in preparation for a VFR approach and landing at Des Moines. Four minutes later while descending through 5,000 feet at an airspeed of 240 knots, the aircraft struck a flock of Mallard ducks. The aircraft hit at least 12 of the birds, one of which hit and penetrated the copilot's windshield panel while another hit but did not penetrate the Captain's windshield panel. The crew members were hit with broken glass about the face and one received serious cuts. The aircraft received strike damage but was landed safely at Des Moines by the Captain. Examination of the broken windshield by the aircraft manufacturer revealed the vinyl properties were normal with no measurable loss of plasticity. The manufacturer reported that the fact the 5- by 7-inch hole in the windshield was sharp edged with no perceptible bulging or stretching of the vinyl layer indicated that the vinyl temperature was below the desired range to maintain its optimum impact resistance.

17.5.66	VC 10	G-ARVA	BOAC	Nr. Bombay	Scheduled Passenger	?	Crew	0	0	?	Substantial
							Pass.	0	0	?	

The aircraft was operating on a scheduled flight from Colombo to Bombay. During the approach to land on runway 27 and at an altitude of approximately 1,000', the aircraft passed through a flock of 50 to 60 large birds (believed vultures). A bump was felt and vibration was experienced together with a rise in No. 4 exhaust gas temperature. The engine was shut down approximately 5 seconds later. On investigation after landing, it was found that one or more of the birds had been ingested into the No. 3 engine. This caused all the blades of the first stage of the L.P. compressor to fail at the root, and as a consequence the L.P. compressor casing came adrift from the intermediate casing, all retaining bolts having sheared. The Godfrey compressor came adrift from the engine together with its oil tank and cooler. The constant Speed Drive was also partially adrift from the engine. Some debris from this engine appears to have been projected forward, and was ingested by the No. 4 engine.

15.9.66	L-188	N6111A	American	Montezuma New York	Scheduled Passenger	11	Crew	0	0	6	Substantial
							Pass.	0	0	5	

Right horizontal stabilizer struck by Mallard drakes during normal cruise.

28.7.68.	Jet Falcon	N367E	Jet Aviation	Lake Erie	Executive	3	Crew	0	0	3	Destroyed
							Pass.	0	0	0	

During takeoff from Burke Lakefront Airport the aircraft struck a flock of gulls, collided with a vehicle and boundary fence and crash landed in the lake. The 3 crew were picked up by a pleasure boat and the aircraft was later lifted by crane out of approximately 21' of water.

A total of 315 dead seagulls was found in the area after the July 25 accident. General Electric Technical representatives stated that one engine compressor unit was 20% filled with bird debris the other 17%.

Probable Cause: Bird ingestion and failure of Air Traffic Personnel to advise Airad given just before takeoff. Hazard notice not posted in operations.

23.7.69.	DC 3	F-OCKT	Air Djibouti	Off Khor Ambadu	-	4	Crew	0	0	2	Destroyed
							Pass.	0	0	2	

Ditched in the sea nine miles west of Djibouti whilst operating a flight from Tadjoura to Djibouti. 4 occupants were rescued.

Aircraft struck number of Cranes whilst flying at 300' suffering multiple propeller strikes causing blockage of the carburettor air intakes and thus failure of both engines.

Date	Aircraft	Regn.	Operator	Location	Nature of Flight	Total Aboard		Injury to Occupants F	S	M/N	Damage to Aircraft
1.12.69.	Boeing 707-321B	N892PA	Pan American World Airways	Sydney, Australia	Scheduled Passenger	136	Crew Pass.	0 0	0 0	11 125	Substantial

The takeoff was being carried out by the First Officer from the right hand seat and, after the first Officer had applied takeoff thrust, the Captain took control of the throttles while the Flight Engineer made fine adjustments to the throttle settings to balance the power. As the aircraft accelerated at an apparently normal rate the Captain called progressively "80 knots your steering", "one hundred" and "vee one". Almost immediately after the "vee one" call the aircraft struck a flock of seagulls and there were two sharp reports from outside the aircraft. The Captain observed a decay in Number 2 engine EPR and aborted the takeoff. The Captain's recollection of the sequence of events was that the power loss occurred shortly after the aircraft attained 100 knots and before V_1 speed and the recollection was shared by other crew members.

The Captain was scanning the engine instruments at the time the aircraft struck the birds and loss of power from Number 2 engine occurred. He saw the Number 2 EPR drop from its setting of 1.85 to about 1.55 and this initiated his decision to abandon the takeoff. The Flight Engineer also saw the EPR drop to about 1.55 and called that there was a power loss. The Captain has stated that he applied considerable braking simultaneously with the selection of speed brake and reverse thrust and full braking almost immediately afterwards. During the early stages of the deceleration, the Flight Engineer saw several flickers of the anti-skid lights on the brake panel, he noted that the hydraulic pressure was normal and saw that the four reverse lights were illuminated and that the N_1 values on all engines was about 110% with EPR indications "well up". When the Captain took control of the aircraft the first Officer assisted by maintaining the nosewheel on the ground and keeping the wings level and, when reverse thrust was applied, he also placed his feet on the brakes and found that the pedals were fully depressed.

The aircraft overran the runway and struck sections of the approach lighting installation which caused the nose landing gear assembly and then the port main landing gear assembly to be removed. Finally, the nose of the aircraft came to rest partially embedded in soft ground 560 feet beyond the end of the runway and the crew and passengers then evacuated the aircraft.

Probable Cause(s) The probable cause of the accident was that, in the circumstances of an abandoned takeoff the aircraft could not be brought to a stop within the nominally adequate runway length because of an error in the calculation of load, a reduction in wind velocity from that forecast and the use of rolling start and braking techniques which would not ensure most effective use of the available runway length. D.C.A. Australian Special Investigation Report 69-1.

7.2.70.	F27	-	IAC	Nr.Bhopal	Scheduled Passenger	40	Crew Pass.	0 0	0) 0)	40	Substantial

Collided with a vulture shortly after takeoff causing damage to the wing and fuel tank. The aircraft returned and made a safe emergency landing with fuel streaming from the damaged tank.

10.4.70.	Trident	AP-AUG	P.I.A.	Lahore	Scheduled Passenger	?	Crew Pass.	0 0	0 0	? ?	Substantial

Made emergency landing back to Lahore after the aircraft struck a vulture after takeoff. The vulture penetrated the nose section and instrument panel and struck the Captain. The co-pilot took over control and a safe emergency landing was made. Estimated weight for the vulture was 20 lb.

26.5.70	Super VC10	G-ASGO	BOAC	Calcutta	Scheduled Passenger	?	Crew Pass.	0 0	0 0	? ?	Substantial

During a climb at 3500ft. the aircraft flew through a number of large birds one of which was ingested by No. 3 engine. There was a sharp noise at impact and the engines developed severe vibration. Fire/severe failure drill was carried out on No. 3 engine and the first shot fire bottle was discharged.

After the fire warning system had been checked No. 4 engine was seen to be losing power and the HP cock lever was vibrating. The fire/severe failure drill was carried out on No. 4 engine and the vibration decreased. No fire warning was indicated on either engine and no fire developed.

The starboard main gear was lowered by its emergency system and the aircraft returned to Calcutta where an overweight landing (129 000 kg) was carried out. The maximum landing weight is 107 500 kg.

During the landing run normal braking was used until the hydraulic pressure decreased and then standby braking was selected. As a result No. 4 rear tyre scuffed and burst. The aircraft was stopped when clear of the runway and the passengers disembarked in the normal manner.

Examination of No. 3 engine showed evidence of a large bird strike in the form of a large dent at the bottom of the intake leading edge. There was severe damage to the entry guide vanes and the compressor rotor and stator blades as far as was visible through the engine. The CSD and the CSD oil tank had broken away from their mountings and both wheelcases were partially adrift due to attachment point failures.

No. 4 engine had suffered severe EGV and LP compressor damage which is thought to have been caused by ingestion of blading from No. 3 engine. In addition vibration had caused failures of mounting points of the CSD and CSD oil tank.

18.8.71.	DC 9	N3316L	Delta	Savannah	Scheduled Passenger	60	Crew Pass.	0 0	0 0	4 56	Substantial

Aircraft departed Savannah Ga. on IFR flight plan for Atlanta, Ga. While climbing through 2000 feet altitude at an indicated airspeed of 200 kts. a buzzard was struck.

Parts of bird penetrated radome, pressure bulkhead at fuselage station 41 and entered cockpit in area of co-pilots feet.

All DC power was lost. Crew switched to emergency power and landed at Savannah without further incident.

Pressure bulkhead found to have break approximately 10 inches long vertically and 4 inches wide laterally.

You DC circuit breakers are located on the back side of pressure bulkhead.

On resetting four circuit breakers all electric systems functioned satisfactorily.

A circuit breaker of the same type as used in N3316L was obtained from Stock. By holding the breaker in one hand and striking it sharply with the palm of the hand from the side that would be forward as mounted in the aircraft, it was found that it would trip or open. By pressing the reset button the breaker could be closed.

The pressure bulkhead at station -41 is .040 inch CLAD 2014-T6 metal.

30.10.72	DC 10	N106AA	American Airlines	Tulsa Oklahoma	Scheduled Passenger	57	Crew:	0	0	10	Minor
							Pass:	0	0	47	

The aircraft took off from Runway 17 at Tulsa International Airport. Soon after rotation and during initial climb at approximately 200 feet altitude, the aircraft flew through a large flock of birds later identified as gulls. There was an immediate loss of engine No 1 RPM and roughness was felt on engine No 3. Power on both the affected engines was reduced to near idle and take-off power maintained on the No 2 engine until landing approximately ten minutes later on the same runway.

Examination of No 1 engine revealed severe fan damage. All blades mostly outboard the shroud were heavily gouged. Seven blades had segments missing outboard the shroud as large as 5 x 3 inches. The fan tip abradable seal was heavily damaged and N 1 sensors rubbed. Bird remains were evident in the engine core, the extent of damage, if any, will be determined during engine teardown. The nose cowl internal accoustical material one foot forward of fan around 360° circumference contained numerous shrapnel type holes up to 2 x 5 inches in size. The fan access cowl was penetrated 2 x 5 inches, at 2.30 clock position, rear view, eight inches forward the nose cowl trailing edge. There was no visible damage to the turbine. The No 3 engine damage was similar to No 1 engine but to a lesser degree and the nose cowl was not completely penetrated. Both the No 1 and No 3 engines were replaced. The No 2 engine was not affected. The weather was 700 feet overcast, seven miles visibility with light rain.

Bird remains were evident on the three landing rear linkages, in the right ram air intake and underside left wing root area. The right landing light lens was shattered and the left inboard aileron contained a 5 inch slash on the bottom side. (Source - ICAO Summary No 44).

15.12.72	Boeing 747	N602US	Northwest Airlines	Miami	Scheduled Passenger	160	Crew:	0	0	11	Substantial
							Pass:	0	0	149	

A Northwest Airlines B747 ran off the end of Runway 27L while landing at Miami International Airport, Miami, Florida on December 15, 1972 at 1714 eastern standard time. The nose landing gear collapsed, which resulted in substantial damage to the aircraft structure in that area. During take-off from Runway 27R a few minutes earlier, the aircraft had collided with a flock of gulls. The crew had shut down the No 4 engine, which was believed to have been causing vibration, and then had requested clearance to return to Miami. The local weather at the time of the accident was 1300 ft broken, 3000 ft overcast, visibility 2½ miles, wind 130° at 9 knots. A thunderstorm was southwest of the airport and moving eastward. The National Transportation Safety Board determines that the probable cause of this accident was the ineffective braking capability of the aircraft on the wet runway because of the low coefficient of friction of the new runway surface and insufficient engine reverse thrust to decelerate the aircraft. The combined effects of the lack of the No 4 engine reverse thrust and malfunction of the No 3 engine reverser resulted in a directional control problem and restricted the use of Nos 1 and 2 engine reversers.
In view of the potential hazard involved in overrun accidents, the Board recommends that the Federal Aviation Administration expedite its research program to determine the friction characteristics of wet runways, not only for its effect on the landing certification requirements for aircraft, but also for the certification of runway surfaces under the new Airport Certification Regulations. On April 10, 1973, Runways 9R/27L and 9L/27R were grooved to increase the coefficient of friction and improve the wet-runway landing conditions.
(Source NTSB-AAR-73-13)

26.3.73	Gates Lear 24	N454N	Machinery Buyers Corp	Atlanta Georgia	Executive	7	Crew:	2	0	0	Destroyed
							Pass:	5	0	0	
							Others:	0	1	0	

A Gates Learjet Model 24, N454RN crashed at 1012 eastern standard time on February 26, 1973, following the take-off from De Kalb-Peachtree Airport, Atlanta, Georgia. The two crew members and five passengers were fatally injured, and one person on the ground sustained serious burns. The aircraft was destroyed by impact and ground fire. An apartment building was damaged, three parked vehicles were destroyed and another vehicle damaged by impact and fire. The aircraft departed from Runway 20L to Miami, Florida. Ground witnesses observed smoke trailing from the aircraft as it crossed the field boundary. The DeKalb-Peachtree Tower controller advised the crew of N454RN that the aircraft's left engine appeared to be emitting smoke, whereupon the crew of N454RN responded that they had 'hit some birds'. The tower controller inquired whether N454RN was returning to land, and N454RN responded 'Don't believe we're gonna make it'. The aircraft initially collided with the roof of a three-storey apartment building approximately 2 miles south-southwest of the airport. The aircraft came to rest in a ravine adjacent to a highway, 165 feet southwest of the damaged apartment building.
About 30 minutes after the crash the remains of 15 cowbirds were found within 150 feet of the Runway 2R (the departure end of Runway 20L) threshold. A municipal garbage dump is located adjacent to the airport just east of Runway 2R/20L. During the investigation, large flocks of birds were observed on the airport and birds numbering in the thousands were seen swarming over the dump area.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of engine thrust during take-off due to ingestion of birds by the engines, resulting in loss of control of the aircraft. The Federal Aviation Administration and the Airport Authority were aware of the bird hazard at the airport; however, contrary to previous commitments, the airport management did not take positive action to remove the bird hazard from the airport environment.

Note: The left engine showed 14 separate strikes, and the right showed at least 5 strikes; the engine intake diameter is approximately 16 in, and area 182 sq in. The weight of a cowbird (Molothrus ater) is approximately 45 gm, compared with a starling (Sternus vulgaris) which is 85 gm. (Source NTSB-AAR-73-12)

30.4.73	Boeing 747	VH-EBB	Qantas	Sydney Airport	Scheduled Passenger	366	Crew: Pass:	0 0	0 0	? ?	?

Just after take-off the aircraft flew through a flock of sea gulls causing power loss on one engine and external damage to another. A third engine is reported to have failed completely. After dumping fuel a safe emergency landing was made back at Sydney.

12.12.73	Falcon 20	LN-FOE	Fred Olsen	Norwich Airport	Executive	9	Crew: Pass:	0 0	0 0	3 6	Destroyed

The aircraft was taking-off at 15.37 hours (dusk) from Norwich airport and on becoming airborne, just over half-way along the 1840m long runway the crew saw a flock of birds ahead flying just above the ground. The pilot slightly increased the aircraft's climb attitude and the flock passed underneath. A few seconds later a second flock was seen at a higher level directly in the aircraft's flight path. The pilot lowered the nose and the flock passed overhead. On re-establishing the climb a third flock was seen directly ahead, extending from ground level to well above the aircraft with no possibility of avoiding it. Almost immediately the crew heard the sound of multiple bird strikes on the aircraft. On both engines the RPM ran down very fast and EPR and TGT instrument readings also dropped. A bang was heard from the engines, followed by the sound of engines running down in a rough and abnormal manner. By this time the aircraft was at a height of 300 ft, still with the gear down. The speed had been 150 kts prior to impact. The pilot saw a field ahead and slightly to the left which he considered suitable for a forced landing, the pilot made a left turn and lined up the aircraft for an approach to the selected field avoiding trees at the approach end in spite of poor visibility and approaching darkness. A positive touchdown was made, the stall warning having sounded just before the aircraft hit the ground. All three landing gear legs were torn off and the aircraft came to rest after sliding for 135 metres on the fuselage belly. All occupants were evacuated through the main cabin door. There was no fuel leakage.

A total of approximately 35 dead Herring Gulls (Larus agentatus) and Black-Headed Gulls (Larus ridibundus) were found towards the end of the runway. The largest complete bird weighed 450 gm (1 lb). There was evidence of two firm and one glancing strikes on the airframe and each engine showed evidence of having ingested at least one bird. The left engine had suffered a hard strike on the fan, which is situated to the rear of the engine, eleven complete fan blades were broken off and eight others were partially broken off and bent. Some of the broken fan blades penetrated the shroud casing and other parts were driven forward and ingested into the core engine causing compressor damage sufficient to make it stall and thus cause the whole engine to run down. In the right core engine a group of three first stage rotor blades and ten second stage blades had been "feathered" with further damage and bird remains through the compressor. There were also bird remains in the bleed air ducting. The damage would have led to repeated compressor stalls and/or surging with subsequent loss of power. (Source - AIB Report No)

> Editorial Note
>
> In 1974 a start was made on the inclusion of Serious Incidents in addition to Notifiable Accidents. 'Serious' has been defined as
>
> (a) Loss of life
> (b) Injury to occupants
> (c) Destruction of aircraft
> (d) Damage/loss/shutdown of more than one engine
> (e) Uncontained engine failure
> (f) Fire
> (g) Significant sized hole eg shattered radome, holed windscreen, holed wing
> (h) Major structural damage
> (i) Particularly unusual or dangerous features eg complete obscuring of vision, multiple loss of system, damage to helicopter blades or transmissions.

6.10.74	Douglas DC10-30CF	PH-MBG	Martinair	Amsterdam		Crew: Pass:	0 0	0 0	? ?	Minor

During night take-off from Amsterdam using full power from runway wet with light rain, birds were struck at approx 140 knots. After rotation but before gear-up vibration felt and flight engineer stated "maximum vibration engines 2 and 3" and that engine 3 N_1 had touched 114%. Thrust was decreased on engine 3 but vibration remained at maximum and engine was shut down. During shut-down Tower reported seeing flames, there was no fire warning but one extinguisher shot was used. Fuel jettisoned and made radar monitored ILS approach with 2 engined procedure. During the initial approach with flaps 22°, power on engine 2 had to be increased to MCT in order to keep flying level. On the glide path engine 2 kept at 75% N_1, with varied power on engine 1. Automatic approach down to 100 ft, reverse idle on engine 1 and 2. Approx 20 dead gulls found on runway, the only complete gull weighed 450 gm (1 lb). The core of engine 3 showed blade rub on compressor stages 2, 3, 4 and each stage had a few blades with nicks or a curled tip. Damage was only slight and operationally insignificant. The core of engine 2 was not damaged, but fan debris caused dents and punctures of inlet duct, and bellmouth seal was pierced near fan speed sensor. No debris passed outside engine cowls. (Source Netherlands DoT).

25.9.74	Lear Jet 24D	Business Air Service	Västerås	Crew: Pass:	0 0	0 0	? ?	Minor

During early morning take-off struck gulls at 135 kts, 30 ft, both engines were damaged such as to be unserviceable. (Source - Swedish Reporting System)

16.10.74	Cessna Citation			Newhaven Connecticut		3	Crew: Pass:	0 0	0 0	0 0	Destroyed

During take-off from Tweed-Newhaven airport, the aircraft ingested gulls in Engine 1. Take-off was abandoned, but the aircraft hydroplaned and left the runway, and struck a ditch. There were no injuries to occupants. (Source - FAA)

12.12.74	SN 601 Corvette		Air Alpes	Chambery			Crew: Pass:	0 0	0 0	0 0	Minor

During take-off struck jackdaws (Corvus monedula) at 50 ft, 120 kts. Both engines were damaged and both pitot tubes required replacement (total cost of incident 60,000 US dollars). (Source -

28.1.75	Lear 23			in US			Crew: Pass:	0 0	0 0	? ?	Minor

Believed struck starlings (passenger report) at 1,500 ft on take-off. At 21,000 ft right engine suffered complete compressor stall and was shutdown. Continued on one engine. On descent to destination, at 17,000 ft the left engine also stalled. Left engine re-started at 7,500 ft on base leg to airfield, right engine started on finals. Found IGVs and several first stage blades severely bent. (Source - Flight Safety Foundation)

14.6.75	Sabreliner NA265-80	N67KM	Kerr-McGee	Waterdown S Dakota		6	Crew: Pass:	0 0	2 1	0 3	Destroyed

Whilst taking off from 7,000 ft long runway aircraft struck gulls during rotation. Both engines immediately "banged" and lost power, and aircraft was crash landed in a field beyond the end of the runway. The wings were torn off and caught fire and the fuselage came to rest approx 750 ft beyond the end of the runway. Both pilots, and one of the 4 passengers sustained serious injuries (the pilots were not using their shoulder harnesses). A total of 13 dead small inland type gulls (Franklin's gull - Larus pipixcan) were found on the runway, they were estimated to weigh somewhat less than 450g (1 lb), and to have a wingspan of 2 to 2½ ft. There was light rain, cloudbase 1,000 ft, visibility 1¼ miles. The two CF700 2D-2 engines were inspected, No 1 core had severe damage and compressor was not rotatable, several variable IGVs and stator vanes were torn from inner and outer bands. The fan was undamaged. Bird feathers were found in a number of locations and charred remains were found in combustion and turbine area. No 2 engine had suffered damage, probably as a result of the crash landing, however bird debris was found in the combustion area. The airport is surrounded by lakes, but gulls are rare on the airport except in spring and autumn. (Source - ICAO Subsequent Notification)

19.6.75	Grumman Gulfstream 1			En-Route	Business		Crew: Pass:	0 0	0 0	? ?	Minor

Struck "plover" whilst at 3,500 ft on approach to Cologne/Bonn airport whilst flying above cloud. Hole 7in x 5in just above front centre of radome. (Source - UK Bird Strike Reporting Scheme)

1.7.75	BAC 1-11	7Q-YKG	Air Malawi	Nairobi			Crew: Pass:	0 0	0 0	? ?	Minor

Struck Marabu Stork (Leptoptilos crumeniferus) on approach to Nairobi. A 10 inch square hole was made in port side of fuselage forward of front passenger door. Skin was damaged for approx 6 feet. Manufacturer's assistance required for repair. (Source - CAA Reporting Scheme)

3.7.75	Lear 25	N428JX	Dana Corp	Boston/ Richmond Airport	Executive	8	Crew: Pass:	0 0	0 0	2 6	Substantial

During take-off from Boston/Richmond Municipal Airport the flight crew heard a "bang". The co-pilot, who was operating the aircraft from the left seat, retarded the throttle to idle and applied the brakes. The pilot-in-command deployed the drag chute and assisted the co-pilot with the brakes. However, the aircraft overran a grass area, severed several trees and a pole 30 cm (12 in) in diameter. It finally came to rest against a wire fence 410 m (1,350 ft) from the end of the runway with the gear collapsed and half of the left wing severed.

Investigation revealed black skid marks on the last 580 m (1,900 ft) of the 1,676 m (5,500 ft) long runway. Both pilots observed birds in front of the aircraft at the time the "bang" was heard. Reverse thrust was not applied during the aborted take-off. Both engines were shipped to General Electric for disassembly and inspection. (Source - ICAO Summary No 1/76)

17.10.75	Boeing 747						Crew: Pass:	0 0	0 0	? ?	Minor

Aborted take-off on cargo flight due to hitting 30 or 40 birds at 155 kts (aircraft weight 772,000 lbs and V1 of 161 kts). Birds rose from the runway directly in front of aircraft (flight was first to use runway 13R). No 2 engine was shutdown because of over-temp condition and failure to go into reverse. No 1 was shutdown after taxying off runway. No severe vibration was felt. No 1 engine had severe fan blade damage, one blade tip approx 8 in long had separated and exited through inlet cowl at 4 o'clock position making 2 holes in outboard flap canoe fairing. No 2 engine also had severe fan blade damage, one blade tip approx 8 in long separated from fan, but was recovered, no tips exited through cowl. Airport Manager stated birds would not be scared away due to rain and low ceiling. (Source - Flight Safety Facts and Reports October 1975)

12.11.75	DC10-30	N1032F	Overseas National	Kennedy A/P New York	Ferry	139	Crew:	0	0	11	Destroyed
							Pass:	0	0	128	

The aircraft was taking off from a different runway from that in use by other aircraft when, shortly after passing 100 knots the captain saw a flock of approx 100 birds rise off the runway ahead of the aircraft. The captain alerted the crew to "watch the EGT's". The aircraft struck the flock of birds, and No 3 engine disintegrated, scattering parts around a wide area, and setting fire to a nearby vehicle maintenance store. The flight data recorder ceased to record soon after the aircraft attained an indicated airspeed of 168 knots (V was 178 knots). The take-off was abandoned, but was affected by the loss of No 2 brake system and braking torque reduced to 50%, No 3 thrust reversers were inoperative, at least three tyres disintegrated, No 3 spoiler panels on each wing could not deploy and the runway surface was wet. The wing was on fire due to rupture of the No engine fuel supply line, and the aircraft finally came to rest on the grass beyond the last taxyway at the end of the runway. The landing gear collapsed and ultimately most of the aircraft was consumed by fire. All 139 persons on board, who were employees of Overseas National, successfully escaped from the aircraft.
Approximately 20 dead gulls were found on the runway, identified as Herring gulls (Larus argentatus), Ring-billed gulls (Larus delawarensis) and Great black-backed gulls (Larus marinus). The largest bird weighed 5 lbs and the average weight of the other birds was between 3 and 4 lbs. There was evidence of at least six significant bird strikes on the lip assembly of No 3 engine inlet cowl. The ingestion caused massive fan blade damage to the GE CF6-50 engine and, ultimately, fan rotor imbalance. When the fan rotor assembly became unbalanced the epoxy abradable rub shroud around the inside of the cowling began to pulverize and entered the HP compressor. It then exploded, the overpressure within the compressor section caused the compressor cases to separate and structural integrity of the engine to be lost.
A number of recommendations were made concerning bird control measures and engine modifications. All CF6-6 and -50 engines have now been modified in that the epoxy rub shroud has been replaced by alloy honeycomb material. (Source - NTSB Aircraft Accident Report NTSB-AAR-76-19)

20.11.75	HS125	G-BCUX	Hawker Siddeley	Dunsfold Surrey	Demo	9	Crew:	0	0	2	Destroyed
							Pass:	0	0	7	
							Others:	6	0	0	

The aircraft took off with two pilots and seven passengers on board, becoming airborne shortly before the half way point. At a height of between 50 and 100 feet and after the undercarriage had been retracted, at a speed of approx 150 kts the aircraft encountered a flock of lapwings (Vanellus vanellus). Both engines ingested birds and although there were no instrument indications the aircraft commander sensed an immediate loss of power on both engines. Ground witnesses saw balls of flame of varying length behind each of the engines. The aircraft was force landed straight ahead with undercarriage and flaps lowered, touching down with only 180 metres of runway remaining at a speed of approx 120 kts. It overran the end of the runway and continued across grass fields and through three hedges before crossing a main road at a speed of approx 85 kts. In so doing it struck and demolished a passing car killing the driver and five children. The undercarriage was torn off and the aircraft continued for a further 150 metres before coming to rest. Fire broke out, but all nine occupants safely evacuated the aircraft before it was largely destroyed by the fire.
A total of 11 dead lapwings were found on the aerodrome, the largest of which weighed 303 grams and had a wingspan of 610 mm. The accident took place 5 minutes after sunset and the aircraft's landing and high intensity supplemental strobe lights were in use. Approximately 40% of the aerodrome had "long grass", but there were many birds uniformly abundant in the short grass areas. Subsequent examination showed that both engines had ingested birds, causing a surge condition, however the damage was such that both engines were capable of being test run.
(Source - Accidents Investigation Branch Aircraft Accident Report 1/77)

29.12.75	Boeing 707	4X-ATX		Tel Aviv Airport			Crew:	0	0	?	Minor
							Pass:	0	0	?	

During a daylight landing on runway 12, with landing lights ON, struck a flock of black-headed gulls (Larus ridibundus) average weight 300 gms. Two engines and both wings were damaged. (Source - Lloyds List and BSCE Member)

1.1.76	DC10-30	LN-RKA	SAS	Copenhagen Denmark	Ferry	13	Crew:	0	0	13	Substantial
							Pass:	0	0	0	

During a night take-off with 13 on board from runway 22L when aircraft was at 100 ft and 175 kts it struck flock of gulls. Pilot heard loud bang and No 1 engine lost power. Aircraft returned safely. A total of 28 black-headed gulls (Larus ridibundus) were found on runway. It is believed that between 9 and 15 birds went through No 1 and 3 engines. The weight of the birds was between 240 and 340 grams. There was severe damage to No 1 engine, including failure of the casing which had started to open up. There was also minor damage to No 3 engine and the left wing. The weather conditions were 7/8 cloud, base 500 ft, slight rain, and due to aerial damage two ILS approaches were made. The cost of repairs are estimated to be approx 1½ million US dollars. (Source - Bird Strike Committee Denmark and ICAO Subsequent Notification)

23.1.76	Boeing 747		Pan American	Istanbul Turkey			Crew:	0	0	?	Minor
							Pass:	0	0	?	

During take-off birds were ingested into No 3 and 4 engines, aircraft returned but neither engine was shutdown. Bird struck were gulls and "hawks", and a dead bird was found in No 8 canoe fairing. Seven fan blades were replaced on No 3 engine and six on No 4, and there were cuts in cowlings. (Source - Aviation Week, February 2, 1976 and correspondence)

6.2.76	Lear 24	I-AMME		Bari Italy	Business	2	Crew:	0	0	2	Substantial
							Pass:	0	0	0	

The aircraft was at an altitude of 450 ft, and speed of 125-130 kts when it encountered a flock of gulls. Both engines, fuselage, wings and gear were struck, and it came to rest in a small field. The 2 occupants were uninjured. (Source - Italian Reporting System)

13.2.76	B747		Air France	Paris Orly			Crew:	0	0	?	Minor
							Pass:	0	0	?	

During the take-off run at 165 kts struck flock of black-headed gulls (Larus ridibundus). Fifty three tonnes of fuel were jettisoned before landing. It was found that engine 1 was badly damaged, and engine 4 required replacement fan blades. (Source - French Reporting System)

10.3.76	Boeing 747	G-AWNI	British Airways	Prestwick			Crew:	0	0	?	Minor
							Pass:	0	0	?	

At approx 110 kts during the take-off on runway 13 aircraft struck flock of birds, engine 4 had high vibration and ran down, and take-off was abandoned. All fan blades were damaged, nose cowl extensively damaged with 2 holes in outer case, fan blade tips missing. The weather was 8/8 cloud at 1,300 ft with rain. (Source -

14.4.76	Boeing 747	G-AWNK		Prestwick	Training		Crew:	0	0	?	Minor
							Pass:	0	0	?	

At 50 ft, 160 kts during take-off on a training flight the aircraft struck a flock of gulls (believed Herring gulls - Larus argentatus or Lesser black-backed gulls - Larus fuscus). There was a loud bang, power loss, fire warning and tower reported 200 ft long flame and pieces falling. Engine was shutdown and fire bottles fired. Vibration with engine shutdown even at 165 kts. Inspection showed 2 fan blades broken and all other blades damaged, one foot square hole right through nose cowl outer skin. Cowlings displaced, pylon panels and exhaust cone missing, reverser sleeve displaced, leading and trailing edge flaps holed. Weather was 3/8 at 4,000 ft, visibility greater than 10 Km. There were 6 crew on board. (Source - UK Reporting System)

27.8.76	Boeing 747		British Airways	Hong Kong			Crew:	0	0	?	Minor
							Pass:	0	0	?	

At 400 ft after take-off two large birds seen to go under right wing. Found 13 x 6 inch hole in flap canoe fairing outboard of engine 3. Remains of small hawk (Falconiformes) removed. (Source - UK Reporting System)

12.11.76	Falcon 20	N27R	Reynolds Tobacco	Naples Florida	Business	11	Crew:	0	2	0	Destroyed
							Pass:	0	9	0	

Before the accident airport employees had dispersed a flock of gulls from the runway. Most of the gulls departed but about 30 returned. The radio normally carried by the bird scaring team was unserviceable. By this time (8.55 local, daylight) the aircraft had started its take-off run. Shortly after becoming airborne it passed through the flock, both engines failed and the aircraft crashed. The fuselage was severely damaged, a wing separated and all eleven occupants were seriously injured. The gulls were ring-billed gulls (Larus delawarensis). (Source - ICAO Subsequent Notifications and US Sources)

14.1.77	DC8-63		KLM	Amsterdam Netherlands			Crew:	0	0	?	Minor
							Pass:	0	0	?	

At 160 kts on take-off struck flock of gulls (Larus spp). Engine 2 was shutdown, fuel jettisoned and aircraft returned. Engines 1 and 2 were damaged. (Source - Netherlands Reporting System)

3.7.77	Lockheed 188 Electra						Crew:	0	0	?	Minor
							Pass:	0	0	?	

Engine 2 suffered bird strike prior to landing, shutdown. During subsequent inspection found engine 3 also damaged. Both engines changed. (Source - US FAA Service Difficulty Reports)

11.7.77	Boeing 747SP		Japan Air Lines	Tokyo Haneda	Scheduled Passenger	300	Crew:	0	0	?	Minor
							Pass:	0	0	?	

At approximately 2700 ft several sharp explosion and airframe jolts were heard. Flames in vicinity of engine 1 were observed by the Captain as birds had been ingested through the engine. He shutdown No 1 engine, at the same time as the Flight Engineer observed a rapidly climbing EGT on engine No 2, and shut it down as the EGT reached 920°. The aircraft continued to climb (TOW was 523,300 lbs) and was passing 3800 ft at 220 kts when a return was requested from ATC. An attempt was made to start No 2 engine, but was abandoned when the N2 was seen to be zero. No 1 engine was restarted but cabin crew reported smoke in the cabin and the engine was again shutdown when the EGT was increasing rapidly beyond 700°. The aircraft landed 13 minutes after take-off 70,000 lbs above maximum landing weight. The No 2 engine failure was caused by a bearing failure, but no fault was found in No 1 engine. (Source - Air Safety from Pakistani International Airlines)

5.8.77	Convair 440		Linjeflyg	Nr Oernsk- oeldsvik Sweden			Crew: Pass:	0 0	0 0	? ?	Minor

At approximately 1700 ft during the descent at 240 kts the aircraft struck a buzzard (Buteo sp). A hole about 8 inches wide was made in the wing leading edge just outboard of the engine. (Source - Swedish Reporting System).

9.8.77	Boeing 707		TWA	San Francisco			Crew: Pass:	0 0	0 0	? ?	Minor

Struck birds on take-off, No 1 engine stalled, aircraft returned. Found engine 1 compressor damaged, and engine 4 fan blades damaged. Engine 1 changed, No 4 fan damage dressed out. (Source - US FAA Service Difficulty Reports)

14.8.77	Comet		Dan-Air	En-Route	Scheduled Passenger		Crew: Pass:	0 0	0 0	? ?	Minor

Found on arrival that engines 1 and 4 were damaged such as to require replacement. No birds seen en-route and no sign of problems from engine indications. (Source - UK Reporting System)

15.9.77	Boeing 737			Near Honolulu			Crew: Pass:	0 0	0 0	? ?	Minor

Aircraft was three miles from the outer marker at 240 kts, and had just broken out of the overcast when a large black bird thought to be a frigate (Fregata sp) appeared in front of the aircraft. The First Officer was flying the aircraft, the Captain shouted a warning, but the bird struck the First Officer's windscreen, completely shattering all panes. Both crew members were covered with broken glass, the screen bowed in, but did not fail completely. The Captain landed the aircraft. (Source - Flight Safety Foundation)

16.8.77	Gates Lear 24	N56LS	-	Baton Rouge Louisiana	Pleasure	8	Crew: Pass:	0 0	0 0	2 6	Substantial

When near rotation the aircraft struck a large flock of birds. Birds were ingested in the left engine which flamed out. The pilot aborted the take-off, but could not stop the aircraft on the wet runway. The aircraft overran and collided with a ditch. The concrete runway was 6900 ft long (Source - ICAO Summary 2/78)

3.11.77	Boeing 747		United Airlines	Newark Airport New York			Crew: Pass:	0 0	0 0	? ?	Minor

Bird strike just after take-off on engine 3, followed by power loss and vibration. Engine was shutdown. One fan blade had detached and made 7 x 8½ inch hole in nose cowl, extensive LP and HP compressor damage. Bird believedto be gull (Larus spp). (Source - US FAA Service Difficulty Reports)

9.1.78	Falcon Fan Jet			Merced California			Crew: Pass:	0 0	0 0	? ?	Minor

Aircraft descending through 2,000 feet and in the clouds struck a goose. The bird penetrated the right wing leading edge, damaging wing spars and puncturing the fuel cell. Aircraft made a successful landing. (Source -

23.1.78	Boeing 707		Air Carrier	Ben Gurion Tel Aviv			Crew: Pass:	0 0	0 0	? ?	Minor

During take-off, the aircraft hit a flock of gulls with an unknown number of birds entering the No 2 engine, causing an engine fire. Aircraft returned and landed. Loss of engine caused by fan and compressor failure. (Source -

26.1.78	Boeing 707		TWA	Tel Aviv Israel			Crew: Pass:	0 0	0 0	? ?	Minor

During take-off a flock of gulls (Larus spp) caused an engine fire and the aircraft's return. (Source - Lloyds List)

11.2.78	Boeing 727		Air Carrier	San Diego California			Crew: Pass:	0 0	0 0	? ?	Minor

On approach to Lindbergh Field, the aircraft struck a golden eagle, destroying the radome. Aircraft made a successful landing. The bird was found lodged in the pressure bulkhead behind the radar antenna. (Source - FAA)

18.2.78	Boeing 747		Air France	Lyon (Satolas) France	Scheduled Freight	3	Crew: Pass:	0 0	0 0	3 0	Substantial

The aircraft was taking off when it struck two very dense flocks of gulls (Larus spp). The take-off was abandoned at 152 kts (V_1 was 154 kts). No 3 engine had failed and No 4 was surging, and the windscreen was totally obscured by bird remains. The runway was wet and the aircraft was stopped only 150m from the end of the 3900 metre runway, with 3 tyres deflated. In addition to changing engines 3 and 4, engine 1 needed 12 replacement fan blades, and engine 2 four fan blades. (Source - ICAO ADREP Report 4/78 and French sources)

20.2.78	Boeing 707		Egyptair	Sharjah UAE	Scheduled Passenger	97	Crew: Pass:	0 0	0 0	7 90	Minor

Just after take-off at only a few hundred feet, the aircraft struck a flock of birds. The birds badly damaged the engines and sections of the fuselage, but the pilot managed to return for an emergency landing. There were no injuries to the 97 occupants. (Source - Lloyds List).

29.2.78	DC-10		Air Carrier	San Francisco			Crew: Pass:	0 0	0 0	? ?	Minor

On take-off, the aircraft struck a flock of gulls, breaking the nose radome and ingesting birds into the No 1 engine. The aircraft returned and landed. Inspection of the CF-6 engine revealed that 20 fan blades had failed. (Source - FAA)

15.3.78	VC10		Air Malawi	Nairobi Kenya	Scheduled Passenger		Crew: Pass:	0 0	0 0	1 ?	Minor

At approximately 400 ft just after take-off the aircraft struck a large bird, later identified as a Marabou Stork (Leptoptilos crumeniferus, average weight 4 kg). The co-pilot's windscreen was crazed, but not penetrated, however particles from the inner pane caused minor injuries to the co-pilot's face. The aircraft jettisoned fuel and returned. (Note:- On this date at Nairobi an Alitalia B707, and two British Airways B747s suffered engine damage). (Source - UK Occurrence Reporting System)

16.3.78	Falcon Fanjet 20			Newark N Jersey			Crew: Pass:	0 0	0 0	? ?	Minor

At 200 feet on take-off climb, the aircraft struck a flock of birds. One bird tore a hole in the right flap while another bird entered the right engine resulting in failure of the blades in the first, second, and third stage compressor. (Source - FAA)

4.4.78	Boeing 737	OO-SDH	Sabena	Gosselies Belgium	Training	3	Crew: Pass:	0 0	0 0	3 0	Destroyed

A trainee pilot was making a touch and go landing under the supervision of an instructor, and was about to become airborne again when the aircraft struck a flock of wood pigeon (Columba palumbus). The take-off was abandoned at a speed higher than V_1 and the aircraft could not be stopped before it overran the runway. The right main gear collapsed and the right engine was torn from the aircraft. The aircraft stopped 300 metres beyond the runway after crossing a road, having spun through 180°. The aircraft was destroyed by fire. Examination of the left-hand engine found that several birds had been ingested. (Source - ICAO ADREP Report and Belgium sources)

19.4.78	Lear 24			Pal Waukee Airport Chicago			Crew: Pass:	0 0	0 0	? ?	Minor

On take-off roll, birds were ingested into both engines. Take-off aborted when both engines flamed out. (Source - FAA)

7.6.78	Boeing 737		Air Carrier	Stockton California			Crew: Pass:	0 0	0 0	? ?	Minor

Climbing through 2,000 feet, the aircraft hit a single bird, bending the inboard trailing edge flap. Damage was sufficient to jam the flaps in a split flap configuration, affecting aircraft performance. (Source - FAA)

-.-.78	Boeing 747						Crew: Pass:	0 0	0 0	? ?	Minor

During take-off at approximately 130 kts, a small bird crossed in front of the aircraft. Soon afterwards there was a loud compressor stall, and engine 4 fire warning came on. The take-off was abandoned at 144 kts, the fire check list completed and the warning stopped after approximately 15 seconds. The aircraft stopped safely, but the runway had to be closed because of engine debris, including the tailcone. The bird (estimated to weigh one pound), broke two solid-type fan blades, causing imbalance and titanium fire. The engine casing was burned through near the 10th compressor stage, the engine was described as "a total loss". (Source - PIA Air Safety, June 1978)

9.7.78	Boeing 747		KLM	Amsterdam Netherlands			Crew: Pass:	0 0	0 0	? ?	Minor

During take-off roll, engine 4 suffered bird ingestion and fire warning. Take-off abandoned. Found two fan blades broken, causing severe imbalance. The pieces were contained, although the HP compressor casing suffered a burn-through at 10th stage manifold. (Source - Netherlands and UK Defect System)

25.7.78	Convair 580	N4825C	North Central AL	Kalamazoo USA	Scheduled Passenger	43	Crew: Pass:	0 0	1 2	2 38	Destroyed

At 0702 hrs EDT, just as the aircraft passed V_1, a sparrow hawk (Accipiter nisus) struck the left engine, and the left propeller auto-feathered as the aircraft lifted off. The aircraft turned to the left and flew for 1 minute 19 seconds before it crashed into a cornfield.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the captain to follow the prescribed engine-out procedures during instrument meteorological conditions, which allowed the aircraft to decelerate into a flight regime from which he could not recover. Contributing to the accident were inadequate cockpit co-ordination and discipline. (Source - NTSB-AAR-79-4)

26.7.78	DC3	TG-ATA	Aviateca	Peten Guatemala	10	Crew:	0	0	2	Substantial
						Pass:	0	0	8	

During take-off struck flock of birds, force landed with no injuries to 10 occupants. (Source - Lloyds List)

13.8.78	Boeing 727		Air Carrier	Nr Houston Texas		Crew:	0	0	?	Minor
						Pass:	0	0	?	

While holding at 10,000 feet MSL, aircraft hit a flock of ducks. Two access doors were torn loose on the left side of the aircraft. On post flight inspection, three fuselage dents and one three-inch diameter hole in the fuselage were also found. (Source -

3.9.78	DC-8		Air Carrier	Tampa Florida		Crew:	0	0	?	Minor
						Pass:	0	0	?	

Immediately after landing, the aircraft rolled through a flock of gulls that were rising off the runway. Birds were ingested into engines No 3 and No 4, the fire warning lights flickered, and the engines were shut down immediately. Maintenance inspection revealed no engine damage. (Source - FAA)

9.9.78	Boeing 707		Pacific Western	Vancouver Canada		Crew:	0	0	?	Minor
						Pass:	0	0	?	

Gulls (Larus sp) were struck during take-off, engine 3 was severely damaged and failed, while engine 4 sustained damage and had to be shutdown. A total of 29,000 lbs of fuel was jettisoned before the aircraft could return for a two-engined landing. Engines 3 and 4 were changed. (Source - Canadian Bird Committee)

21.9.78	DC-3			Oakland California		Crew:	0	1	?	Minor
						Pass:	0	0	?	

Immediately after take-off, the DC-3 collided with a large bird, possibly a hawk, shattering the co-pilot's windshield. Glass fragments cut the co-pilot's face and eyes causing permanent vision impairment. Second officer received cuts about the face and hands. Pilot landed aircraft without further incident. (Source - FAA).

22.9.78	Boeing 737		Air Carrier	Flint Michigan		Crew:	0	0	?	Minor
						Pass:	0	0	?	

On take-off roll, aircraft ingested gulls in both engines, an immediate power reduction was made and aircraft aborted the take-off. The engines were cleaned and released for service with no damage. (Source - FAA)

2.10.78	Boeing 747		Air Carrier	San Francisco		Crew:	0	0	?	Minor
						Pass:	0	0	?	

On take-off roll, aircraft experienced two compressor stalls following ingestion of domestic pigeons into two engines. Aircraft aborted the take-off. Engines were checked and no damage was found. Two tyres were replaced because of the high-speed abort. (Source - FAA)

7.10.78	Boeing 707		British Airways	Prestwick		Crew:	0	0	?	Minor
						Pass:	0	0	?	

During a training flight a touch and go landing was made, during which engine 1 throttle was closed between V_1 and V_R to simulate an engine failure. At 50 ft the aircraft passed through a large flock of Lapwings (Vanellus vanellus) causing engines 2, 3 and 4 to surge. No 1 was opened up, while No 4 continued to surge, and had to be shutdown. After landing damage was found to engine 4. (Source - UK Reporting System)

28.10.78	Boeing 737		Air Carrier	Cleveland Ohio		Crew:	0	0	?	Minor
						Pass:	0	0	?	

Descending through 8,000 feet at 250 knots, the aircraft struck a flock of ducks. One duck passed through the right side fuselage. Remains were found in the forward baggage hold. (Source - FAA)

30.10.78	Falcon Fanjet 20			Fort Lauderdale Florida		Crew:	0	0	?	Minor
						Pass:	0	0	?	

At 800 feet on take-off climb, the aircraft struck a brown pelican. The right engine nacelle was destroyed, the bird was ingested, destroying the right engine, and the engine mount was bent, tearing the fuselage skin aft of the engine mount. The pelican weighed about eight pounds. (Source - FAA)

2.11.78	Boeing 727		Air Carrier	Portland Oregon		Crew:	0	0	?	Minor
						Pass:	0	0	?	

Aircraft aborted take-off after hitting a hawk. The hawk broke the stall warning sensor resulting in stall warning stick shaker activation just prior to V_1. (Source - FAA)

24.11.78	Fairchild FH227	Air Carrier	Des Moines Iowa	Crew:	0	0	?	Minor
				Pass:	0	0	?	

During the approach to Des Moines Airport, the aircraft struck a goose at 2,500 feet, causing damage to the nose gear door. The nose gear could not be lowered requiring a nose gear up landing. No injuries were reported; however, extensive damage was done to the forward undercarriage of the aircraft. (Source - FAA)

11.12.78	Cessna Citation		Lebanon New Hampshire	Crew:	0	0	?	Minor
				Pass:	0	0	?	

During landing, the aircraft hit a snowy owl that was hunting by the light of the approach lights. The bird made a large hole in the leading edge of the left wing, rupturing the fuel cells. (Source - FAA)

AWG 2
Issue 1
15 October 1979

BIRD STRIKE COMMITTEE EUROPE
ANALYSIS WORKING GROUP

ACCIDENTS AND SERIOUS INCIDENTS TO LIGHT AIRCRAFT
Aircraft under 5700 kg (12500 lbs), excluding Executive Jets

3 April 1912 | Model EX Wright Pusher | Long Beach, California | Fatal

Bird strike hazard history was made on this date with the crash of the Wright Flyer and the death of Calbraith Perry Rodgers. This first reported crash and fatality occurred as Cal Rodgers was flying low along the beach and hit a gull, causing the aircraft to plunge into the ocean. The pilot was pinned under the wreckage and drowned. One fatality.

10 February 1939 | Arado Aircraft | Madras, India | Fatal

Shortly after take-off struck large bird. Pilot and passenger killed.

About 1955 | Cessna Aircraft | Aberdare Mountains, Kenya | Fatal

Aircraft hit a vulture during en-route phase of flight and crashed. Pilot tried to avoid bird, but hit it with wing causing damage that jammed ailerons. One fatality.

10 January 1959 | Light Aircraft | Serengeti National Park, Tanganyika | Fatal

Aircraft struck a Griffon vulture and crashed. One fatality.

March 1963 | Beechcraft 35 | Near Bakersfield, California | Fatal

Aircraft struck common loon and crashed due to loss of stbd tailplane. One fatality.

February 1964 | Turbulent | Belfast, Northern Ireland | Fatal

Aircraft believed to have struck a large gull and crashed. Dead gull with impact injuries consistent with having been struck found 63 yards from wreckage. One fatality.

17 November 1968 | Beechcraft 95 | Hamilton, Illinois

Aircraft collided with a goose, breaking windshield. Pilot made a forced landing.

20 November 1978 | Beechcraft 95 | Cairo, Illinois

En-route aircraft hit a flock of geese with substantial damage to the vertical stabilizer. Aircraft made a safe landing with no injuries.

13 October 1969 | Piper PA23 | Des Moines, Iowa

Aircraft struck a flock of large birds at 3,500 feet MSL. Pilot made a forced landing at Des Moines after aircraft experienced flight control difficulties and substantial structural damage.

12 March 1970 | Cessna 150 | Opalocka, Florida

On student pilot's first solo, the aircraft struck a flock of gulls on take-off. The windshield was broken and pilot attempted a forced landing resulting in substantial aircraft damage.

12 November 1970 | Bellanca 14 | Santa Rosa, California

Aircraft's right wing hit a turkey vulture, causing substantial damage to wing. Aircraft landed without further incident.

2 July 1971 | Cessna 180 | British Columbia | Fatal

An en-route bird strike with a bald eagle caused the aircraft to crash. Three fatalities.

9 September 1971 | Cessna 180 | Minot, North Dakota

On landing approach, aircraft hit two gulls diverting attention of pilot resulting in hard landing, gear collapse, and ground loop. Aircraft destroyed and pilot received minor injuries. | Destroyed

26 March 1972 | Piper PA28 | Lower Lake, California

On final approach, aircraft hit an owl, puncturing leading edge of right wing resulting in loss of fuel. Aircraft landed with no further incidents.

16 April 1972 | Mitsubishi MU-2 | Atlantic City, New Jersey | Fatal

On climb, the aircraft hit a flock of geese, breaking the windshield and incapacitating one or both pilots. Aircraft entered an uncontrolled descent and crashed in the Atlantic Ocean. Two crew and one passenger killed.

22 October 1972 — Cessna 175 — Miami, Florida

On descent for landing, aircraft hit a black vulture causing damage to the wing. Airflow over wing was altered sufficiently to cause a significant increase in stall speed.

31 July 1973 — Aerial Spray Callair A-9A — Grygla, Minnesota — Destroyed

Aircraft struck a sandhill crane during a spray swath, damaged the right aileron, and the pilot was unable to maintain aircraft control. Aircraft was destroyed and pilot seriously injured.

7 November 1973 — Piper PA32 — Corpus Christi, Texas

Aircraft collided with large flock of birds while climbing through 4,000 feet above ground requiring an emergency landing. Aircraft sustained substantial airframe skin damage.

22 August 1974 — American AA5 — En-route near Homestead, Florida

Aircraft hit a bird at 500 feet above ground level and the aircraft hit a tree after momentary loss of control. Aircraft damaged during crash landing.

26 January 1975 — Pushpak Trainer — Patiala, India — Destroyed

Aircraft was in the traffic pattern when it struck a vulture. The wing strut was damaged causing loss of control. The aircraft was destroyed on impact.

12 April 1975 — Piper PA30 — Iowa City, Iowa

Aircraft was in the traffic pattern, hit a flock of ducks causing substantial airframe damage.

26 January 1976 — Cessna 150 — Bath, South Carolina

While en-route, aircraft hit a hawk, shattering the windshield. Pilot made a forced landing in an open field and hit tree stumps causing substantial damage to aircraft. Pilot and passenger sustained minor injuries.

15 May 1976 — Piper PA28 Cherokee — Near Biggin Hill, UK

Whilst cruising at 150 kts at 1,800 ft struck one of a pair of crows (Corvus spp). The stabilator (combined tailplane and elevator) was severely damaged and had to be replaced. The leading edge was torn and structure penetrated such that the spar was damaged.

12 June 1976 — Cessna 210 — McMinnville, Oregon

During cruise, bird impacted nose gear doors and jammed the doors in the closed position. Aircraft landed gear-up causing substantial damage to lower nose cowling.

2 July 1976 — Cessna 402 — Ngorongoro, Tanzania

Whilst in circuit aircraft struck tawny eagle (Accipter rapax). Bird initially struck port engine leaving wing inside intake. Remains struck port tailplane at approx 3/4 span causing major failure of spar, ribs and skins.

19 August 1976 — BN2A Islander — Samburu Airstrip, Kenya

During descent and approach large bird struck wing leading edge bending downwards and back to main spar. Aircraft difficult to control at normal landing speeds. Believed bird was diving when it struck aircraft.

4 September 1976 — Cessna 150 — Luton, UK

At 200 ft hit a flock of pigeons. Propeller and windshield struck. Pilot made a forced landing without damage following engine shutdown.

10 February 1977 — Piper PA28 — Nottingham, UK

During climbout, aircraft struck a flock of lapwings breaking the windshield and causing facial lacerations to the pilot. A safe landing was made.

7 April 1977 — Piper PA23 — Glasgow, UK

At 3,000 feet above ground level and 160 knots, the aircraft struck a lesser black-backed gull causing a 12-inch diameter hole in the wing leading edge. Aircraft landed without further incident.

14 April 1977 — Cessna 150 — Atlanta, Georgia

On a local flight, aircraft hit a hawk, windshield was destroyed, and aircraft landed without further incident. One crewman seriously injured, other crewman received minor lacerations.

23 April 1977 | Aero Commander 690A | Chicago, Illinois | Fatal

Pilot was advised of birds on the runway at Meigs Field. Pilot took off into a flock of birds, ingesting gulls in one engine. Aircraft emergency procedures were improperly executed and aircraft entered a spin and crashed in the water, killing the pilot and three passengers.

9 August 1977 | Beech 18 | Sioux Falls, South Dakota

During a night flight, aircraft hit a bird with impact occurring on the windshield dividing bar, breaking the left windshield. Pilot received minor injuries.

29 August 1977 | Victa Airtourer | Glamorgan, UK

Windscreen holed when a pigeon (Columba sp) was hit at 70 kts and 300 ft on the climb out.

30 August 1977 | Cessna 170B | Golovin, Alaska

On take-off climb, aircraft hit a bird which penetrated the engine cowling and struck the ignition system lead wires causing partial power loss. Aircraft was forced to ditch resulting in substantial water damage to aircraft. Pilot and four passengers survived with only minor injuries.

12 September 1977 | Callair A-6 | Cedar City, Utah | Destroyed

A mourning dove was ingested blocking airflow to the engine. Engine failed and aircraft was destroyed in crash. The pilot was seriously injured.

10 January 1978 | Cessna 172 | Sacremento, California

Aircraft climbing through 3,000 feet struck a goose causing windshield failure and injury to the pilot and one passenger. Aircraft made an emergency landing and both the pilot and passenger were treated for lacerations on the face and hands.

25 January 1978 | Beech Aircraft | USA

The aircraft, carrying cargo, encountered a flock of birds whilst on a circling approach. Power was lost on the right engine, but the approach and landing were continued. Just after touchdown another flock was struck, causing the left-hand engine to lose power. The aircraft was towed to the parking area.

8 February 1978 | Piper PA31 Navajo | Near Edinburgh, UK

During the descent at 2,700 ft and 180 kts struck a bird believed to be a herring gull (Larus argentatus, weight 1.1 kg). The First Officer's windscreen disintegrated, and the Captain's was cracked. The bird hit the top of the screen where it joins the roof, causing the roof to buckle and split. The electrical panel in the roof containing the magneto switches was damaged. The bird was flying above 4/8 cloud at 1,500 ft.

3 February 1978 | Cessna 210 | Brunette Downs, Australia

Shortly after take-off the left wing struck a large bird and was substantially damaged. The pilot had control difficulties, but landed the aircraft safely.

23 February 1978 | Beech 35 Bonanza | Sacremento, California

During descent at night, aircraft encountered a flock of ducks with one duck hitting the wing leading edge, tearing the aircraft skin, and rupturing the fuel tank. Aircraft declared an emergency and landed, all fuel was lost from the wing.

7 March 1978 | Piper PA31 | Sacremento Executive Airport, California

During a night flight, the aircraft struck a flock of ducks, two ducks broke through the windshield injuring the pilot and his passenger. A successful emergency landing was made.

29 March 1978 | Piper PA28 | Tweed-New Haven Airport, Connecticut

On approach to the airport, the aircraft hit a gull at 2,000 feet. The bird passed through the right side of the windshield, no injuries.

4 April 1978 | Commuter Skyvan SH7 | Nr Philadelphia, Pennsylvania

During level flight at 3,500 feet, the right front windshield was destroyed by a bird. No injuries reported.

22 April 1978	Grumman AA5B	Near Stonesville, Ohio	

During a night flight at 2,500 ft, the aircraft hit a hawk. The bird passed through the windshield injuring the passenger in the right seat.

14 June 1978	Piper PA25 Pawnee	Near Manston, Kent, UK	Destroyed

While spraying, birds flew out of the wheat crop directly in front of the windscreen. The pilot's attention was distracted and the wheels entered the crop. The aircraft pitched forward and the pilot was unable to avoid striking the bank of a canal. The landing gear was torn off and wings, propeller and fuselage damaged. The pilot was uninjured.

26 June 1978	Piper PA31 Navajo	Walla Walla, Washington	

On take-off, aircraft struck a bird that jammed in the nose gear, causing a gear retraction problem. Aircraft landed without incident. Bird was removed and gear retraction tests showed no damage.

31 July 1978	Piper PA28	Madison, Wisconsin	

During cruise at 5,500 feet, aircraft encountered a flock of ducks; a bird broke the underwing fuel drain causing complete loss of wing tank fuel. Aircraft made an immediate landing with the engine quitting on landing roll due to fuel starvation.

7 August 1978	Piper PA23 Aztec	Esbjerg, Denmark	

During training flight struck a flock of gulls (Larus sp) during touchdown at about 80 kts. All parts of the aircraft were struck, and the wing leading edge was severely damaged, grounding the aircraft for two weeks. The weather was clear and landing lights were used.

23 August 1978	Cessna 150	Danburg, Connecticut	

At 100 feet in the take-off climb, the aircraft struck a Canadian goose, puncturing a three-inch by four-inch hole in the wing leading edge.

28 August 1978	Piper PA24	Portland International Airport, Oregon	

On take-off, aircraft ingested starlings into the heat muff, resulting in a fire in the duct.

September 1978	Cessna 402	Honolulu, Hawaii	

Cruising at 1,000 feet over the water, the aircraft struck a frigate bird, shattering the windshield and destroying some flight instruments.

28 September 1978	Cessna 310R	Majir, Northern Kenya	

During landing aircraft struck a vulture (Falconiformes). The windscreen was shattered and the two passengers injured.

27 October 1978	Piper PA32	Location unknown	

At 6,000 feet, aircraft struck a bird at night resulting in failure of the right windshield, lacerating the passenger's face and hands.

20 November 1978	Cessna 172	Birmingham, Alabama	

On take-off climb, the aircraft hit a large bird, blocking off airflow at the engine air intake resulting in a loss of power and a forced landing. No injuries reported.

6 December 1978	Beagle 206 Series 2	Corfu, Greece	Destroyed

Shortly after the aircraft became airborne, a flock of gulls flew up in front of the aircraft, several being struck. The gear was raised, and as the aircraft passed the end of the runway the manifold pressure started to decrease. Full power was applied and the aircraft climbed to approximately 200 ft, the other instruments being normal. The manifold pressures continued to fall and when they had reached 26" the aircraft could not maintain height and at 50 ft and 80 kts during a slow left turn back towards the airport, the left engine failed, causing the wing to strike the water. The aircraft plunged into the sea, and both occupants escaped with minor injuries through the smashed windscreen. The aircraft sank in approximately 50 seconds, and the crew were successfully rescued.

Date unknown	Cessna Aircraft	Shannon, Eire	Destroyed

While flying on a wildfowl census the pilot swerved to avoid a bird strike, the plane somersaulted several times before flying into 12 metres of water, ending up inverted with the doors jammed. The pilot and observer managed to get out of the aircraft seconds before it sank and were able to swim ashore with only minor injuries.

AD F616 090
WP 12

BSCE/A/2

BIRD STRIKE COMMITTEE EUROPE

MILITARY AIRCRAFT

BIRDSTRIKE ANALYSIS 1977

Prepared by: Squadron Leader R Kingston RAF
MOD (Inspectorate of Flight Safety(RAF)) - UK

July 1979

KT

ANALYSIS OF MILITARY BIRDSTRIKES - 1977

Introduction

1. The data used in this analysis was supplied by the following air forces:

   a. Royal Netherlands Air Force (RNLAF)

   b. Royal Norwegian Air Force (RNAF)

   c. Royal Air Force (RAF)

   d. Swedish Air Force (SAF)

   e. United States Air Force (Europe) (USAF(E))

2. Unfortunately not all the data was complete, and some of the tables are not as comprehensive as they might have been. Nevertheless, all the submissions have been included and the number of contributors is included in the 'notes' to each table.

STRIKE RATES

3. Table 1 analyses the strike rates for aircraft in their main role. Strike and recce aircraft show the highest rates once again, although RNLAF continues to record a high rate for the F104 in the air defence role. The Buccaneer again suffered a much higher rate than other RAF Strike aircraft; this is almost certainly a result of its longer sortie length compared with the other types and the employment of some squadrons in the maritime strike and attack note.

AIRFIELD BIRDSTRIKES

4. Table 2 lists the number of strikes at individual airfields and the strike rates for domestic airfields only. The 1976 analysis showed high rates for the RNLAF airfields at Leeuwarden (18.0) and Twenthe (13.3) and it is interesting to note that both rates were reduced in 1977. The figure for Twenthe has been more than halved, and these encouraging improvements are almost certainly a result of the introduction of airfield bird control teams.

5. Excluding the strikes listed as 'unknown' in table 2, 53% occured on and around the airfields and 47% occured on route. This is a slight improvement on the 1976 results when 58% of the total were recorded as 'airfield strikes'.

BIRD SPECIES

6. Table 3 shows the bird species involved in strikes. Gulls of all types featured in 35% of the incidents when the bird was positively identified. Of the other types the Lapwing was once again a high scorer and featured in 12% of the total. However, of the total number of recorded strikes in table 3 (819), the bird was identified in only 46% of the incidents.

PARTS OF THE AIRCRAFT STRUCK AND EFFECT

7. Tables 4, 4A and 5 shows the parts of the aircraft struck, the effect of the strike and the effect against airspeed and weight of the bird. The distribution of strikes is very similar to that reported in 1976; the effect of strike is also very similar with 56% of strikes causing no damage. Two aircraft were destroyed, again the same as in 1976. Finally, in strikes where the bird was identified, 62% of the strikes occured when the aircraft were flying at 250 knots or more.

SW

TABLE 1 AIRCRAFT ROLE

Role	Aircraft Type	Strikes per 10,000 Movements
Strike and Recce	Netherlands	
	F-104G	25.1
	RF-104G	20.0
	NF-5A	17.4
	Sweden	
	AJ 37	14.6
	SH 37	2.9
	S 35	5.1
	A 32	18.5
	S 32	11.7
	United Kingdom	
	Buccaneer	17.29
	Harrier	3.58
	Jaguar	5.93
	Vulcan	2.66
	Canberra	6.44
Air Defence	Netherlands	
	F104	26.0
	Sweden	
	J 35	3.3
	J 32	3.4
	United Kingdom	
	Lightning	1.97
	Phantom	2.54
Transport	Netherlands	
	F 27	3.4
	Denmark	
	C-130H	.768
	United Kingdom	
	Andover	9.99
	Argosy	3.83
	Devon	4.38
	Hercules	4.60
	HS 125	1.70
	VC 10	3.57

TABLE 1 AIRCRAFT ROLE

Role	Aircraft Type	Strikes per 10,000 Movements
Transport (cont)	Sweden	
	All types	4.2
Maritime	United Kingdom	
	Nimrod	8.28
Training	Netherlands	
	NF-5B	18.2
	TF-104G	14.1
	Sweden	
	SK-60	5.5
	SK-61	6.3
	SK-50	2.5
	United Kingdom	
	Bulldog	.43
	Dominie	5.86
	Gnat	2.44
	Hunter	3.82
	JP	2.65
	Hawk	1.49
	Jetstream	1.93
	Chipmunk	0.21
Helicopters	Netherlands	
	Alouette 3	6.1
	BO-105C	6.9
	Sweden	
	HKp 3,4,6	9.2
	United Kingdom	
	Gazelle	2.27
	Puma	1.67
	Whirlwind	1.35
	Wessex	1.29

1.1 There is a minimum of 2 movements per flight.
1.2 Aircraft with no recorded birdstrikes are not listed.
1.3 Data supplied by 4 countries.

TABLE 2 AIRFIELD

AIRFIELD	NUMBER OF INCIDENTS	NUMBER OF MOVEMENTS	STRIKES PER 10,000 MOVEMENTS
1. DOMESTIC, strikes in own country			
NETHERLANDS			
Leeuwarden	27	15,434	17.5
Volkel	20	25,946	7.7
Twenthe	9	14,108	6.4
Eindhoven	6	8,386	7.2
Gilze Rijen	5	9,296	5.4
Ypenburg	2	NK	NK
Soesterberg	3	25,480	1.2
SWEDEN			
Malmstatt	5	16,186	3.0
Ostersumd	2	21,054	0.9
Ljungbyhed	8	33,270	2.4
Karlsborg	4	9,366	4.2
Satenas	7	17,532	3.9
Angelholm	7	23,760	2.9
Nykoping	5	13,250	3.7
Kalmar	4	14,082	2.8
Norrkoping	8	17,970	4.4
Soderhamm	3	14,722	2.0
Uppsala	2	25,374	0.7
Tullinge	2	4,574	4.3
Lulea	2	22,804	0.8
DENMARK (incomplete data)			
Aalborg			4.50
Karup			0.95
Tirstrup			2.27
Vandel			0.00
Skrydstrup			1.52
Vaerloese			1.77
Avnoe			0.00

AIRFIELD	NUMBER OF INCIDENTS	NUMBER OF MOVEMENTS	STRIKES PER 10,000 MOVEMENTS
UNITED KINGDOM			
Fairford	3	5,481	5.47
Benson	7	12,901	5.43
St Mawgan	8	23,796	3.36
Brize Norton	9	30,201	2.98
Llanbedr	2	6,819	2.93
Lyneham	11	40,073	2.72
Marham	7	28,927	2.42
Kinloss	4	16,802	2.38
Wyton	4	22,806	1.75
Boscombe Down	6	38,511	1.56
Dishforth	3	20,568	1.46
Leuchars	5	34,533	1.45
Finningley	5	39,550	1.26
Valley	13	107,311	1.21
Elvington	3	27,262	1.10
Coltishall	3	28,021	1.07
Cranwell	7	77,196	0.91
Lossiemouth	4	44,988	0.89
Honington	3	33,938	0.88
Scampton	2	25,191	0.79
Linton-on-Ouse	7	89,532	0.78
Barkston Heath	3	41,645	0.72
Abingdon	3	46,730	0.64
Coningsby	2	32,603	0.61
Mona	2	32,954	0.61
Binbrook	2	36,238	0.55
Leeming	3	88,934	0.34
Shawbury	3	101,448	0.30
Aldergrove	4	-	-
Cambridge	2	-	-
2. DOMESTIC Airfields with single strikes	18	-	-
3. En route	332		
4. Unknown	76		
5. Total (Data supplied by 4 countries)	697		

BSCE/A/2

TABLE 3 - BIRD SPECIES

COMMON NAME	LATIN NAME	APPROX WEIGHT	CATEGORY	NUMBER OF STRIKES	% BASED ON 378
Gull (various)	Larus Sp	400-1800	B	73	19.3
Lapwing	Vanellus Vanellus	200	B	47	12.4
Blackheaded Gull	Larus ridibundus	400	B	33	8.7
Skylark	Alauda arvensis	40	A	24	6.3
Swift	Apus apus	40	A	23	6.1
Woodpigeon	Columba palumbus	500	B	23	6.1
Passeriformes	Passeriformes	20-110	A	16	4.2
Starling	Sturnus Vulgaris	100	A	14	3.7
Common Gull	Larus Canus	400	B	11	2.9
Thrush	Tardus Sp	60-150	A	8	2.1
Partridge	Perdix perdix	400	B	7	1.8
Linnet	Acanthis cannabina	30	A	7	1.8
Herring Gull	Largus argentatus	1000	B	7	1.8
Meadow Pipit	Anthus pratentis	30	A	6	1.6
Oyster Catcher	Haemotopus ostralegus	550	B	6	1.6
Blacktailed Godwit	Limosa Limosa	250	B	6	1.6
Columbriforme	Columbiformes	180-500	B	5	1.3
Swallow	Hirundo rustica	18	A	5	1.3
Golden Plover	Pluvialis apricaras	170	B	4	1.1
Sparrow	Passer spp	40	A	4	1.1
Lesser Black-backed gull	Larus fusus	800	B	4	1.1
Gannet	Sula bassana	3500	B	3	0.8
Crow	Corvus corone	550	B	3	.8
Kestrel	Falco tinnuculus	200	B	3	.8
Buzzard	Buteo buteo	800	B	3	.8
Little Bustard	Otis tetrax	900	B	3	.8
Fieldfare	Turdus pilaris	100	A	2	.5
Snipe	Gallinago gallinago	115	B	2	.5
Homing Pigeon	Columba livia	400	B	2	.5
Mallard	Anas platyrhrynchos	1000	B	2	.5
Black Grouse	Lynurus tetrix	1100	B	2	.5
Pheasant	Phasianus corchicus	1000	B	2	.5
Stork	Ciconia Ciconia	3000	B	2	.5
Snow Bunting	Plectrophenax nivalis	35	A	2	.5
Heron (Grey)	Adea Cinerea	1400	B	1	.3
Wheatear	Oenanthe Oenanthe	25	A	1	.3
Turtle Dove	Streptopelia turtur	200	B	1	.3
Grey Plover	Phuvialis Squatarola	200	B	1	.3
Common Tern	Sterna hirundo	150	B	1	.3
Knot	Calidris Canutus	110	B	1	.3
Woodcock	Scolopax rusticola	300	B	1	.3
Sandmartin	Riparia Riparia	14	A	1	.3
Willow Warbler	Phylloscopus trochilus	10	A	1	.3
Jackdaw	Corvus monedula	220	B	1	.3
Hawk	Accipiter Gentilis	1000	B	1	.3
Ruff	Philomacus pugnax	160	B	1	.3
Wader (Unident)	-	60-800	A/B	1	.3
Kittiwake	Rissa tridactyla	400	B	1	.3
Arctic Tern	Sterna Paradisea	100	A	1	.3
Redwing	Turdus iliacus	60	A	1	.3
Chaffinch	Fringilla coelebs	22	A	1	.3
Brambling	Fringilla monti fringilla	25	A	1	.3

TABLE 3 - BIRD SPECIES

Total identified -	378
Unknown -	441
GRAND TOTAL	819

Notes:

3.1 The bird categories based on current Civil Airworthiness requirements are:

CAT A below .11kg ($\frac{1}{2}$ lb)

CAT B - .11kg to 1.8kg ($\frac{1}{4}$ to 4lb)

CAT C - over 1.81kg to 3.63kg (4lb to 8lb)

CAT D - over 3.63kg (8lb)

3.2 Those birds not positively identified are tabled as 'unknown'.

3.3 Percentages are based on the total of identified birds.

TABLE 4 PART OF AIRCRAFT STRUCK

	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% Based on 870
Nose (excluding radome and windscreen)	78	17	36	-	131	15.1
Radome	38	2	9	1	50	5.7
Windscreen	90	14	16	-	120	13.8
Fuselage (excluding the above)	85	11	34	1	131	15.1
Engine:-						
1 engine struck	73	17	41	-	131	15.1
2 out of 3 struck	-	-	-	-		
2 out of 4 struck	2	-	-	-	2	0.2
3 out of 4 struck	-	-	-	-	-	
all struck (on multi-engined aircraft)	-	-	1	1	2	0.2
Wing	70	19	47	-	136	15.6
Rotor/Propeller	4	4	16	1	25	2.9
Landing Gear	20	10	31	-	61	7.0
Empennage	14	1	9	-	24	2.7
Underwing Stores/Tanks	34	2	21	-	57	6.5
TOTAL	508	97	261	4	870	
Part Unknown	51	5	15	-	71	
GRAND TOTAL	559	102	276	4	941	

Notes:

4.1. The Total in Table 4 and 4A may be higher than other tables, as one bird can strike several parts.

4.2. The percentages are based on incidents where the part struck is known.

4.3. Multiple strikes are counted as one strike, unless for example both wings or both landing gears are struck, when two incidents should be recorded.

4.4 Data obtained from 5 nations.

TABLE 4A EFFECT OF STRIKE

EFFECT	Weight Unknown	CAT A	CAT B	CAT C/CAT D		TOTAL	% Based 675
Loss of Aircraft	2	-	-	-	-	2	0.3
Flight Crew Injury							
Major	-	-	-	-	-	-	-
Minor	-	-	-	-	-	-	-
Slight	1	-	-	-	-	1	0.1
Premature Engine Change:-							
On single engined aircraft	4	-	11	-	-	15	2.2
1 on a 2 engined "	22	7	13	-	-	42	6.2
1 " 3 " "	-	-	-	-	-	-	-
1 " 4 " "	1	1	-	-	-	2	0.3
2 " 3 " "	-	-	-	-	-	-	-
2 " 4 " "	2	-	-	-	-	2	0.3
3 " 4 " "	-	-	-	-	-	-	-
all engines on a multi	-	-	-	1	-	1	0.1
Windscreen Cracked/Broken	8	3	4	-	-	15	2.2
Radome Changed	5	-	3	-	-	8	1.2
Deformed Structure	8	-	3	-	-	11	1.6
Skin Torn/Light Glass Broken	19	6	21	1	-	47	6.9
Skin Dented	51	8	33	1	-	93	13.8
Propeller/Rotor/Damaged +	-	1	7	1	-	9	1.3
Aircraft System Lost	2	1	-	-	-	3	0.4
Underwing Stores/Tanks damaged	13	-	11	-	-	24	3.6
Miscellaneous	1	1	1	-	-	3	0.4
Nil Damage	271	42	84	-	-	397	
TOTAL	410	70	191	4	-	675	
Unknown	15	4	9		-	28	
Grand Total	425	74	200	4	-	703	

Notes:

4A.1 + Includes Helicopter transmissions.

4A.2 Data obtained from 5 Nations.

TABLE 5 EFFECT - AIRSPEED - WEIGHT OF BIRD

EFFECT (AIRSPEED / WEIGHT)	-80		81-100		101-150		151-200		201-250		over250	
	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D
Loss of Life/Aircraft												
Flight Crew Injured												
Engine Prematurely Changed					2		4		1	2	9	
Windscreen Cracked/Broken	1		1		1						2	
Radome Changed					1						2	
Deformed Structure										1	4	
Skin Torn/Light Glass Broken	1									1	21	
Skin Dented			3		9		3		2	1	15	
Propeller/Rotor Damaged	1				1						1	
Aircraft System Lost												
Underwing Stores/Tanks Damaged							1				7	
TOTAL	3		4		14		8		3	5	61	

NOTES:

5.1. The TOTAL in Table 5 will be very small, as those incidents where the airspeed or the bird weight are unknown, together with the non damaging strikes, have been omitted.

5.2. Data supplied by 3 nations.

AD F 616 091

BSCE 14 / WP 13

New procedures for evaluation of radar information

by Dr. J. Becker, German Military Geophysical Office (GMGO)

1. Present bird warning system in Germany

Migratory movements of birds are observed continually by use of surveillance radar equipments. To distinguish the bird echos from other targets there are made long exposured polaroid photos of the radar screen. The photos are compared with the international 0 - 8 scale for estimating the bird intensity. If the migration has reached an intensity ≥ 4 a bird warning message is transmitted to the GMGO. After an evaluation of the message especially with regard to the warning height and validity a birdtam will be transmitted by teleprinter over the geophysical and air traffic control network. The time between the observation and the beginning of validity generally takes 1/2 to 1 hour. The areas/heights specified in the birdtam are restricted for military jet aircraft.

2. Experience with the birdtam system

The problems with the photographic registration of bird echos are well known:

(i) If the employed types of radars are different, the results cannot be compared exactly.

(ii) The resolution of the radar depends strongly on the used type of indicator and video processing.

(iii) The interpretation of the photos differs, when judged by different persons.

In spite of these disadvantages the German birdtam system had good success in several migration periods as shown in fig.1. During October 1976 the number of birdstrikes could be reduced by birdtam though bird migration reached its highest intensity. In other years however the results were not convincing. The most important factor is the varying quality of radar observation in different years/areas. Fig.2 shows the frequency of birdtam concerning different GEOREF-areas in 1973. The main part of flight restrictions in NW-Germany and East-Bavaria does not reflect the real

birdstrike risk in the whole country, but should be ascribed to chance. If flight restrictions by birdtam shall be justified, a rather homogenous network of observations will be necessary. This demand refers also to informations about the height distribution of bird migration. With the surveillance radar there is generally a gap of information at levels below 1000 ft AGL. Moreover hight finder measurements have an inaccuracy of ±1000 ft. As the main part of bird migration occurs in heights below 2000 ft AGL an exact specification of the height is unrealizable. Unfortunately these heights are the operational space for military low level flights. Fig.3 shows the monthly distribution of birdstrikes in heights below 500 ft AGL, between 500 and 1500 ft AGL, and above 1500 ft AGL. As high level migration mostly does not correspond to low level migration, birdstrikes at lowest levels cannot be avoided by radar observation.

Finally there exists an operational problem of the present birdtam system. As birdtam must be based on real observations of bird migration, they are immediately valid and cannot be considered for flight planning. Therefore a birdtam often causes trouble at the flying units.

3. Improvements of the bird warning system

The disadvantage of the photographic system can be avoided by using an objective electronic counting system for radar echos. But the main problems of the warning system will be still existing. An improvement seems only possible by (i) a thorough evaluation of the radar data/photos/films on hand, and (ii) an evaluation of the actual radar information before issuing the warning. Work on these items has been started in the GMGO.

(i) Since 1970 the GMGO has gathered thousands of polaroid photos and has evaluated many kilometers of radar films. Fig.4 shows the fragmentary knowledge gained by radar observation. Only in relatively small areas the coverage of bird migration is satisfactory. In other parts there is a considerable gap of information. If e.g. bird movements occur in the lower part of fig.4 there is only a small chance for detection.

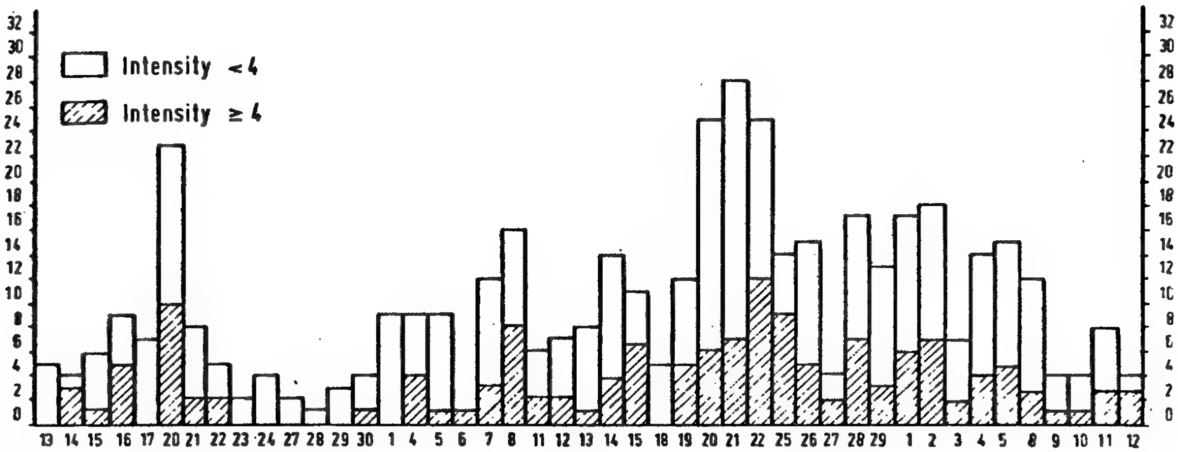
These gaps have to be filled by other data, e.g. the dimensions of bird migration in a certain area and time, visual observations, and weather influence. Using electronic data processing predicting models for the intensity of bird migration in different parts of the country are possible.

(ii) The results of these evaluations are significant for the actual warning procedures. They allow to judge the actual radar informations, and to complete or extend the message if necessary. Comparing the radar information with other bird warning messages (also visual ones) the area covered probably by bird migration can be limited. This procedure is important for operational purposes, because the restricted area should be as small as possible. On the other hand the birdtam should cover the whole space of bird migration.

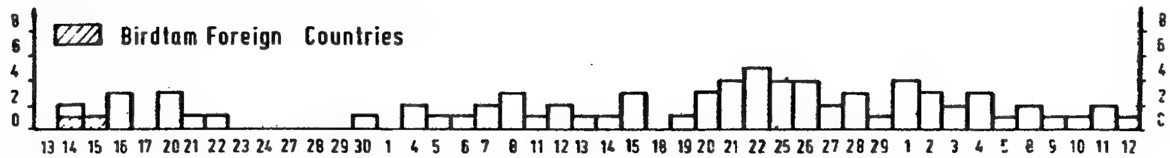
An improvement of the bird warning system is considerably depending on our knowledge about concentrations of bird migration in time and space. One single radar observation does not allow to judge the extent of bird hazards. Bird warning messages or birdtam could be rather formulated, if the observation can be included in a greater context.

BSCE 14/WP 13/Fig. 1

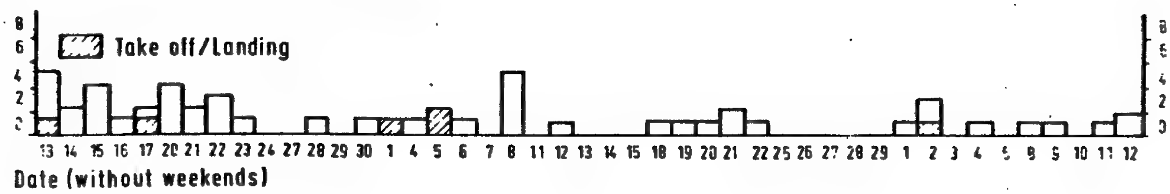
Bird Warning Messages (Radar/visual) 13.09.1976-12.11.1976



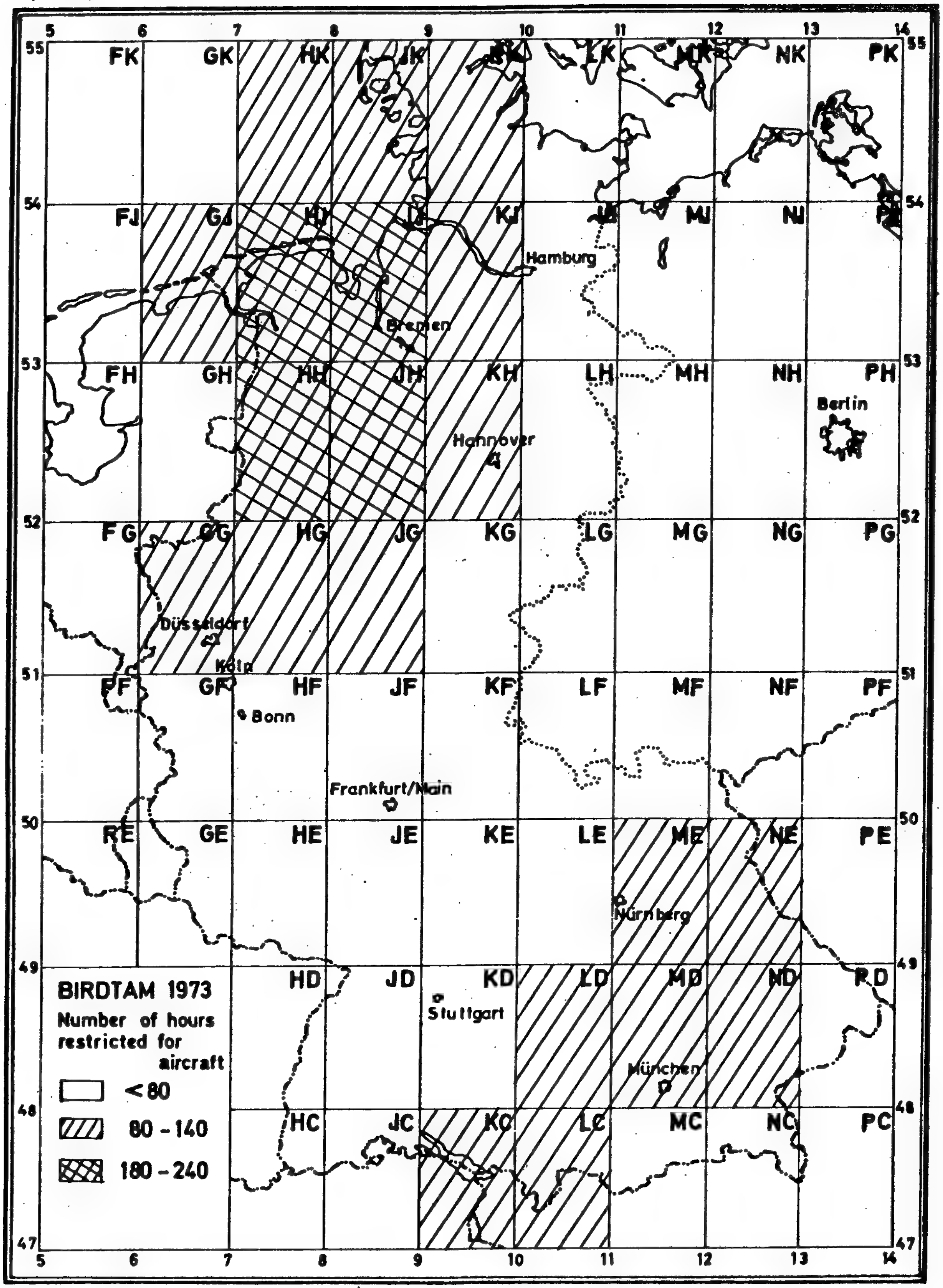
Birdtam 13.09.1976-12.11.1976



Birdstrikes 13.09.1976-12.11.1976

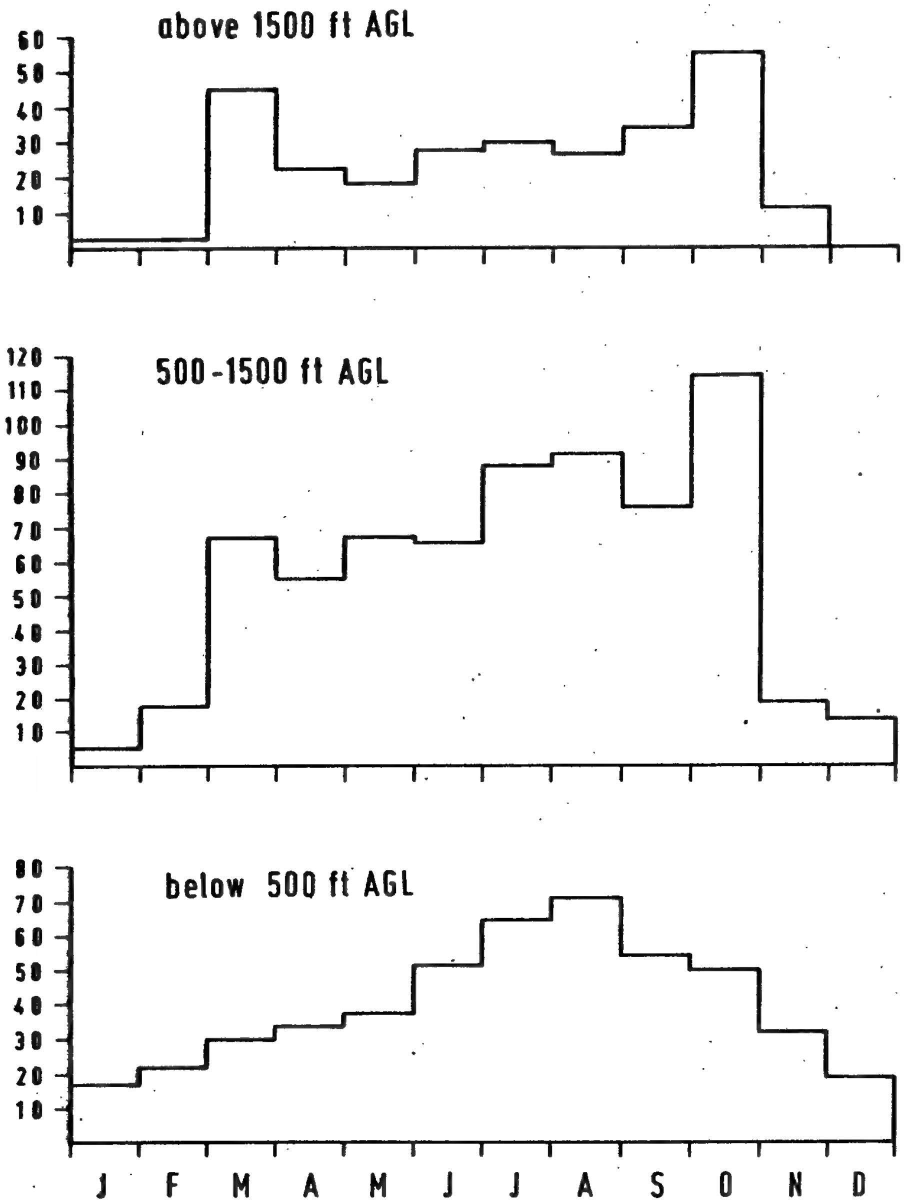


BSCE 14/WP 13/Fig. 2



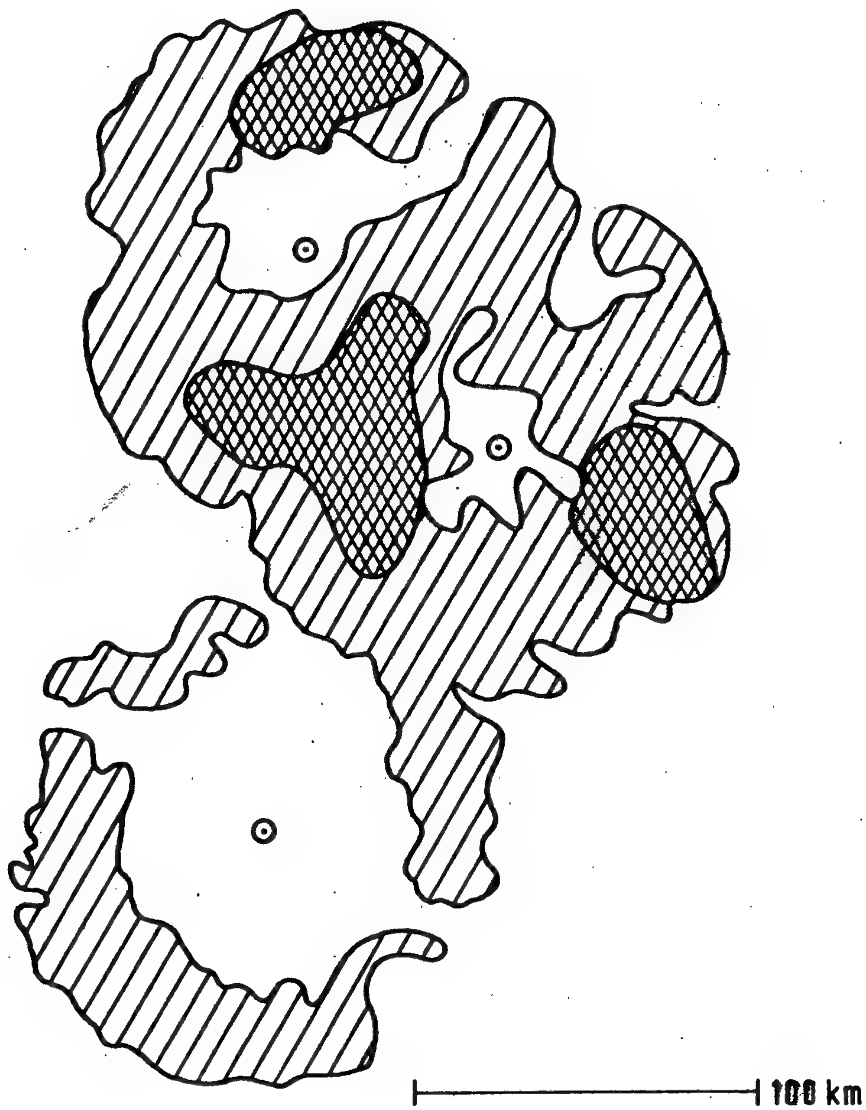
BSCE 14/WP 13/Fig. 3

Monthly Distribution of Birdstrikes 1971-1977
in Different Flight Levels



BSCE 14/WP 13/Fig.4

Coverage of Bird Migration
by Long Range Surveillance Radar



Location of 3 Radar Stations

Radar Coverage of Bird Migration

Areas with Maxima of Bird Echos

AD F 616 092

BSCE/WP 14/79

New Procedures for Publication of Bird Warnings and Forecasts

by Dr.J.Hild,German Military Geophysical Office, 5580 Traben-Trarbach

During the 17th MAS (AIR) Flight Safety Meeting The Netherlands have been appointed to draw up a STANAG - draft "Birdstrike-Risk, Warning Procedure". In German Air Force the following planning exists:

1. The longterm bird movement forecasts published weekly or monthly till today are replaced by a corresponding operating instruction named " Judgement of long-term birdstrike-risk". This instruction will be subdivided into the following sections:

   - Monthly reviews about bird movements without regard of weather but regarding average intensities,flight directions,flight heights, day-course of bird migration, bird species and migration areas.

   - Influence of parameters inducing - favouring/prohibiting - movements for the following periods :

     --- year ---
     --- february 16th until may 15th ---
     --- may 16th until august 15th ---
     --- august 16th until november 15th ---
     --- november 16th until february 15th ---

   - Annual course of bird activities above 1000 ft(GND).

   - Monthly day-course of bird activities regarding day-,night- and dawn-phases.

   - Survey about the most important phenological data for birdstrike-risk below 1000 ft(GND).

   - Monthly maps of birdstrike-risk regarding climatological/meteorological data with special informations about intensities, directions,leading lines,narrow-front migration and areas with high quantities of birds.

This operating instruction will have appx. 60 pages; it will be published in 1980 and sent to all meteorological offices of German Air Force. The old form of longterm movement forecast will be stopped with december 31rst,1979.

2. The birdstrike-risk-forecast , at the moment published daily, now is published by a seperate information since september 3rd , 1979 from monday until friday within a special transmitting series with the head-line FXDL 90 EDZX YY0400. The validity of this forecast is from the day of publication,05.00 Z, until the following day, 00.50 Z;
Amend-ments are possible and have to be transmitted with priority "JJ". If necessary this risk-forecast can include a medium-term amendment up to 3 days.

The risk-forecast includes the following indications:

- Intensity/frequency of bird movements using the terms : light, moderate, severe, isolated, located and frequent.
- Areas as "over hills", "coast", "sea" or special geophysical advisory districts, named A 1 ,A 2, A 3, A 4.
- Flight heights as "up to..... ft(GND)" or "between...... ft(GND) and ...... ft(GND) , but only heights with the highest risks.
- Dependency of the birdstrike-risk on weather.
- Indication of bird species (only larger birds) in case the risk is induced by those birds.

During weeksend and before special holidays birdstrike-risk-forecast is published by the biological staff of German Military Geophysical Office on the last working day.
If neceassary the forecast includes many meteorological alternatives which are selected by the meteorologist on duty

Moreover on thursdays this riskform is completed as appendix by a weekly outlook. The contents of this weekly forecast are based on the forecasted weather in the four special geophysical advisory districts A 1 - A 4 and the German Bight. They show the following indications:

-- Intensities and bird species --
-- Flight heights of birds --
-- Day-course of migration --
-- Phenological data --
--Other important remarks --

As a basis for these weekly forecasts serve:

-- List "weather influence on bird migration" --

-- Official longterm weather forecast --

-- Monthly review about bird migration --

-- Diagrams about day-course of bird-migration --

-- Survey about phenological phases --

3. The hitherto existing birdtam procedure should not be changed at the moment. Only the exchange of warnings/informations with radar stations in Denmark,The Netherlands and Belgium will be improved.

   For the Central meteorological office of the German Military Geophysical Service the biological staff publishs daily birdtam guidances on the basis of the forecasted weather, if necessary differentiated regional. This guidance includes:

   -- General review about bird migration situation.

   -- Maximum flights heights of birds.

   -- Validity of birdtam.

   -- Remarks(f.i.expansion of the forecast-area).

   As basis for these works serve :

   -- Bird warning messages or birdtam of the last 24 hours.

   -- Actual weather forecasts.

   -- List about weather influences in bird migration.

   -- Monthly reviews about bird migration.

   By this method it has been secured that birdtam can be published, if necessary, at every time.

In case the new form of birdstrike-risk-forecast proves good successe it is intended later on to discuss whether it can get a higher obligation. Than, at the same time birdtam would be published only at intensities between 6 and 8 and only on the basis of radar observations.

AD F 616 093

WP 15, BSCE-Meeting 1979

Work Instructions for the Birdstrike Representatives of the Commercial Airports in the Federal Republik of Germany

Dr. Werner Keil, Frankfurt/M.
Birdstrike-Committee Germany

On 13th. February 1974, the regulations for the prevention of birdstrikes in air traffic were published by the Federal Ministry of Transport, which were based on the requirements made by commercial airports serving airline traffic. An essential requirement of these directions is the appointment of a birdstrike representative by the airport operator to supervise the measures to be taken mentioned in paragraphs III and IV. Paragraph III deals with the biotop expertise, and paragraph IV with the individual measures to be taken on the airport. As well as this the representative should receive skilled training and also have the possibility of taking part in suitable advanced courses.

The German commercial airports then appointed birdstrike representatives corresponding to the regulations. In practice it showed very quickly that it was necessary to fix the rights and duties of the birdstrike representative in the work instructions. The German Committee for the Prevention of Birdstrikes in Air Traffic therefore worked out a sample set of instructions in cooperation with the commercial airports. These instructions contain the most important tasks, that the representative has to carry out in the interest of flight safety.

It runs as follows:

1. The representative should support the management of the airport establishment in all measures for the prevention of birdstrikes in air traffic.
2. The representative has a direct right of report, if he was

not able to agree with the responsible quarters and if a decision by the management is necessary because of the importance of the affair.

3. The representative has to supervise all measures according to paragrph III (biotop expertise) and IV (measures to be taken on the airport) of the regulations of the Federal Ministry of Transport of 13.2.1974 and to effect their implementation.

3.1 The representative has to take part in the drawing up of the biotop expertise, according to paragraph III of the regulations, and its extrapolation on the basis of the experiences and findings resulting from the tests.

3.2 The representative is obliged to keep a regular check on the measures demanded in the biotop expertise.
For this purpose a record is to be kept.

3.3 The representative is to be given a hearing about the effects on birdstrikes, for all measures concerning planning in- and outside the airport.

3.4 The representative has also to effect measures for warding off dangers from other animals.

3.5 The representative is to report acute dangers of birdstrikes to the air traffic control at the airport.

3.6 The representative has to collect information about birdstrikes in the airport and in the areas of departure and arrival.

3.7 The representative has to consult a third party at the airport about birdstrikes and their causes.

3.8 The representative should be consulted for making technical statements regarding all planning intentions in the vicinity of the airport, according to the regulations of the Federal Ministry of Transport.

3.9 The representative has to supervise the measures to be taken according to paragraph IV/5 (dead birds) of the regulations of the Federal Ministry of Transport and to evaluate the notes.

4. The representative is to take part in advanced courses, meetings of the German Committee for the Prevention of Birdstrikes

in Air Traffic and other advanced courses.

5. The representative should keep in close contact with the German Committee for the Prevention of Birdstrikes in Air Traffic.

6. The representative makes an annual report to the management about the measures to be taken according to the regulations of the Federal Ministry of Transport and the recommendations of the biotop expertise.

In order to guarantee the training and further studies of the representatives, the German Committee organises an annual conference within the scope of its study group "Airport/Ecology", at which typical questions as well as basic problems are answered. The meetings are to take each time at a commercial airport. Thus the participants will given the oppotunity of informing themselves by concrete examples about the measures to be taken that are dependent on the locality, and of taking home with them important indications for their own work. The birdstrike representatives will also invited to the annual meetings of the German Committee so that they can inform themselves about all the other problems which lie within the scope of the German Committee. Furthermore, the German Committee is available at any time for helping birdstrike representatives solve acute problems. We are of the opinion that we have found such a path that contributes to minimizing the birdstrike risk in the area of the German commercial airports.

WP 16, BSCE-Meeting 1979

Experiences with the Birdstrike Regulations of the Federal Ministry of Transport since 1974

Dr. Werner Keil, Frankfurt/M.
Birdstrike Committee Germany

In the meantime, more than 5 years have passed since the birdstrike regulations of the Federal Ministry of Transport has been published. The present report has the purpose of reporting the experiences that could be gained during that time. In the guidelines (paragraph III), a biotop expertise is required in order to provide the basis for the neeessary measures to be taken for the prevention of birdstrikes at airports. This expertise is produced in cooperation with the German Committee. It should give information about the ecological conditions of the airport and its immediate surroundings. In addition, this expertise should contain proposals for measures to be taken in the light of the local circumstances. The expertise has to be communicated to the airport authorities.

The biotop expertise for the commercial airport Cologne-Bonn had already been taken in hand in 1974. In the meantime the reports for Bremen, Düsseldorf, Hamburg, Hannover, Nürnberg and Stuttgart have been concluded. The reports for Frankfurt and Munich are being dealt with. There is merely an expertise outstanding for the airport at Saarbrücken, the smallest commercial airport in Germany. The report for the Berlin-Tegel airport, which lies in the French sector, still has to be worked out. Ultimately it was mentioned that an ecological report was also being produced for the airport project Munich II. The German Committee is to be informed about every new planning so that constant contact is maintained that results in close cooperation.

Such a report must contain the following points:

1. Statistical data
1.1 Flight movements per year
1.2 Evaluation of the birdstrike reports
1.3 Dead birds (and other animals) on the runways and taxiways
2. Appraisal of the abiotic factors
2.1 Geological subsoil
2.2 Hydrological inventory
2.3 Evaluation of meteorological data
2.4 Determination of garbage dumps, areas of bog and wet land
3. Ecological inventories
3.1 Vegetation (sociological tests for plants)
3.1.1 On the airport
3.1.2 Description of the types of vegetation and their distribution on the airport
3.1.3 Vicinity of airport
3.2 Avifauna
3.2.1 Observations of birds that were made at various times of the day
3.2.2 Survey of the quantitative and qualitative number of breeding, migrating and wintering birds
3.2.3 Mapping of the bird population in the different areas of the airport, taking into special consideration the bird-species that are specially relevant for air traffic
3.3 Other animals
3.3.1 Survey and mapping of the animals in the different areas of the airport
3.3.2 Critical observation of animal species that attract birds
3.3.3 Reciprocation between birds and other animals mentioned
4. Summary of the partial reports 3.1, 3.2 and 3.3
5. Working out of practical recommendations for scaring off the various species of birds in the area of the airport and its immediate surroundings.

The setting up of partial reports is effected in cooperation with specialists at biological institutes. The implementation of the necessary measures takes about 2 years on average. The costs incurred vary according to the local circumstances from DM 15,000 to 30,000.

The measures to be taken after the biotop report has been finished have the purpose of making the airport as unattractive as possible for the species of birds endangered by air traffic. This means, amongst other things, depriving these species of birds of the chance to rest, eat and breed. This can be effected, for example, by chaning the agricultural treatment of the grass surfaces by suitable forestry measures or by removing the nourishment basis. We are of the opinion that the exclusive use of ad hoc methods for scaring off birds (phono- and pyroakustics, setting up of scarecrows, traps etc.) is not sufficient for bringing about an adequate and effective reduction of the danger to birds. Even the measures outlined can not completely remove the danger to birds, but they can reduce it considerably.

Hamburg is mentioned as an example. This commercial airport has an especially high birdstrike index because it is situated near the coast and the special conditions there. This index fluctuates between 12.03 and 15.78 birdstrikes for every 10,000 flight movements. In 1978. the first measures were able to be carried out that had resulted from the biotop expertise. Up to now the number of birdstrikes has dropped considerably. Furthermore, a much smaler member of birds are being observed in the area of the airport than in previous years. The future will tell us whether this trend is continuing.

As well as the biotop expertise, the regulations mention in paragraph IV a whole range of measures that are to be carried out by the air-port operators. It is forbidden to keep sheep, cows, pigs, poultry and pigeons (or else carrier-pigeons). It is not allowed to plant trees whose fruits can serve as nourishment for birds. Waste areas and compost heaps are forbidden in the airport as well as open wet land. Rabbits, for example, are to be kept away from the area of air traffic by the implementation of hunting measures. The fencing around the airport should prevent ground game from getting in.

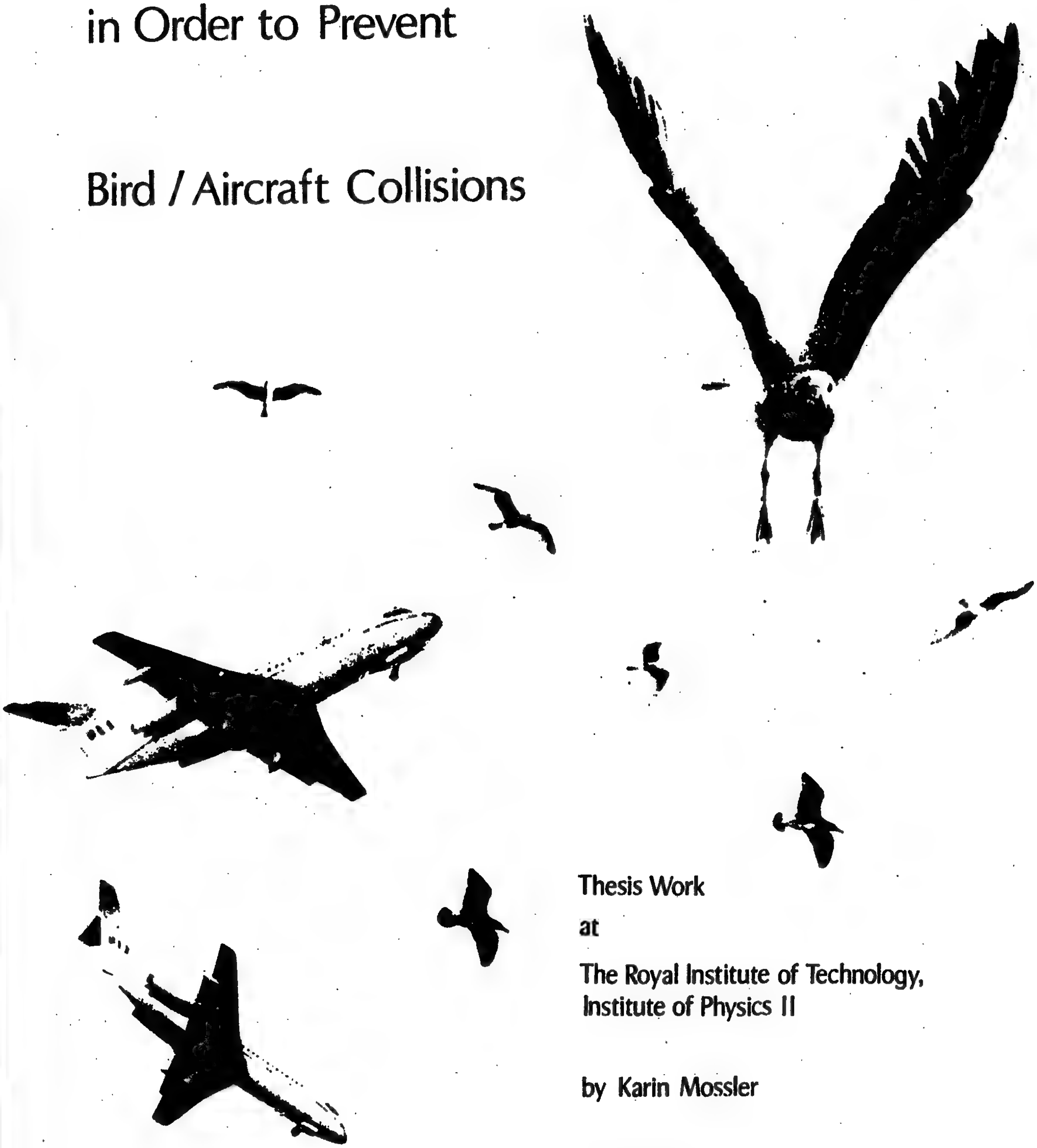
As well as the measures on the airport, the area surrounding the airport is also to be kept under control in cooperation with the responsible institutions. The important points consist in removing the rubbish dumps and avoiding open wet land. It has been shown that

good cooperation between airport operators and the local residents has contributed to a swift and non-bureaucratic removal of the sources of danger.

In conclusion is has been noted that the experiences of the first 5 years since the publication of the birdstrike regulations can be characterized as good. The following years will show us whether the path we have chosen is the right one. We will have something to report at some time in the future.

AD F616 095

Laser and Symbolic Light on Birds in Order to Prevent Bird / Aircraft Collisions



Thesis Work
at
The Royal Institute of Technology,
Institute of Physics II

by Karin Mossler

March 1979
Stockholm, SWEDEN

CONTENT

PAGE

ABSTRACT

This report will deal with the possibility of reducing bird strikes by means of using laser and ordinary light. First previous research on this subject is related, and then experiments with symbolic light of different colours and laser on gulls in nature are discussed in detail.

In the experiments with light, the gulls were found to react with fear to a "flapping" movement in the horizontal plane. The flight readiness as a function of colour was greatest when blue, red and white were used, while green and yellow were less efficient in frightening the gulls.

The experiments with a laser (a helium-neon one of 30 mW) on the gulls showed that the birds reacted to the beam with an avoidance behaviour.

INTRODUCTION

During the last decades the increasing number of birdstrikes has become a worldwide problem. Every year the bird/aircraft collisions cause aircraft damage and great economical losses,(see appendix I). Birdstrikes are also hazardous to man, though human fatalities luckily are rare. Therefore the matter of avoiding birdstrikes is a very important subject.

This report will deal with the possibility of using laser and ordinary light in order to frighten birds away from aircrafts.First some general facts and statistics concerning bird strikes are summarized. Then the sight of a bird is described and previous research on birds concerning the physiological aspects of the eye and its sensitivity of different colours is dealt with. The brain response to different stimuli is then related, followed by a description of fieldtests made on light on birds and the behaviour pattern of birds when exposed to light at night.

Finally experiments using symbolic light and laser on gulls in order to prevent bird strikes are related in detail. But first a short introduction to the bird strike problem.

BIRD STRIKE ANALYSIS

Especially during the last ten-year period, a worldwide cooperation on the collision problem has taken place and several organisations dealing with this matter have been built up.

This development has helped collecting statistics about the circumstances under which the collisions occur, and I will now summarize these figures.

The different factors that influence the bird strike rate may be diveded mainly into three groups, namely factors that concern

a) the aircraft
b) the environment
c) the birds

Statistical facts will now be related within each group.

FACTORS CONCERNING THE AIRCRAFT

TYPE OF AIRCRAFT

Due to type of aircraft, the jets top the bird strike list, while the helicopters have the smallest strike rate [27]. This also seems very natural. The collision between an airplane and a bird is merely a matter of avoidance, and the faster the plane the shorter the time for the bird to escape.

Also the location of the engines [28] influences the collision probability. Wing mounted engines have a higher strike rate than aft mounted ones. The strength and frontal area of the engine are also of importance here.

IMPROVEMENTS

It is impossible to construct an aircraft with an engine which can resist damage caused by a bird collision completely. Of course, the safety can still be improved by technical development, but it is unlikely that an unbreakable engine ever is to be constructed.

On the other hand, according to collision statistics, it would be preferable to choose an aircraft model with aft mounted engines, with as small frontal area as possible.

SPEED AND ALTITUDE

Most of the civil bird/aircraft collisions occur at relatively high speed and at low height. In 1973 [28] 93% of all strikes reported occurred at speeds above 80 knots (148km/h) and 57% of them between 101-150 knots (187-278km/h). The majority of the bird strikes took place within an altitude of 0-200 feet (0-61 metres)[27], in most cases at take off or at landing.

IMPROVEMENTS

It is probably impossible to alter the speed or the flight altitude of the aircraft due to economical losses, delays and technical reasons.

ENVIRONMENTAL FACTORS

AT THE AIRPORT

Most bird strikes occur at take off or at landing [1] [27] in the vicinity of the airport. One reason for this is that when trying to land or take off the aircraft is at a low altitude for a long time, and at this low altitude most birds fly. The airfields around the airport seem also to attract roosting flocks of birds, which find food and shelter in the wide fields. This increases of course the risk of a bird/aircraft collision.

In the vicinity of an airport, a waste disposal is also very often found, and here thousands of gulls find their food. When flying from the roosting area to the refuse tip, the flock of birds cross the airways, where they will be hazardous to the aircraft.

IMPROVMENTS

Removal of waste disposals in the vicinity of the airports, and other methods to make the airport unattractive to birds.

DAILY AND MONTHLY VARIATION IN THE STRIKE RATE

The bird strike rate also shows a seasonal variation. During spring and autumn, when the migration takes place, the collision frequency reaches its maximum. August, September and October [28] here top the list.

A daily variation is also noticable [27]. During daytime, 75% of all collisions bird/aircraft took place. 14% of totally 461 cases in 1975 occured at night - the last figure being high compared to the low proportion of flights at night.

VARYING WEATHER CONDITIONS

Most strikes (65%) happened at clear or cloudy/overcasting weather at daytime [27]. Very few occurred during precipitation or during misty weather. Surprisingly, the strike rate was greater during clear weather (36%) at daytime, than it was during cloudy weather (29%).

FACTORS CONCERNING THE BIRDS

The heavier the species of bird, the greater the hazard to the aircraft! One reason for this is that the bigger birds are capable of flying at higher altitudes than others and when a collision takes place, they also cause damage to a higher extent than the smaller ones do.

Gulls of different kinds possess the characteristics discussed above. They also visit the airports (and the waste disposals) more often and in a greater number than any other type of bird. During 1975, gulls were involved in 51.6% of all incidents [27].

DISCUSSION

In order to reduce the strike rate, several different methods have been tried. Mainly groundbased attempts have been made to frighten the birds at the airports. This has been done with acoustical systems (distress calls, carbide canons, see the BSCE report [26], and the publication mentioned in ref. 8), chemical preparations of the areas around the airport, or by using trained birds of prey (falcons).

There has also been an attempt in Nice [14] to create an ideal roosting area for the birds near the airport, as a better alternative for them than the airport itself.

Of course, ground based equipment could reduce the number of birds in the vicinity of the airport, but still the risk of the aircrafts colliding with a bird at other places, at high altitudes, remains.

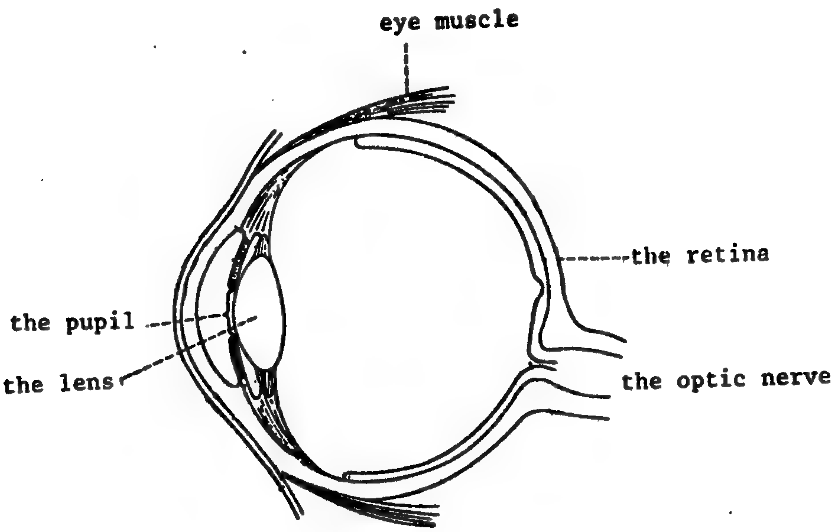
To avoid this, an airborne, bird frightening equipment, attached to the plane, must be used.

Then, what methods are suitable to use for this purpose? What are the most frightening stimuli to the birds, which at the same time could be used in the air, on a plane? To answer these questions, an examination of the birds' sense organs must be performed.

THE SENSE-ORGANS

The sense of taste and smell by birds are fairly undeveloped, and, anyhow, they could not be affected from an airplane. The hearing is as sensitive as that of man. However, due to the birds' difficulty to perceive in due time the sounds from an airplane at high speed, I will not deal with it here.

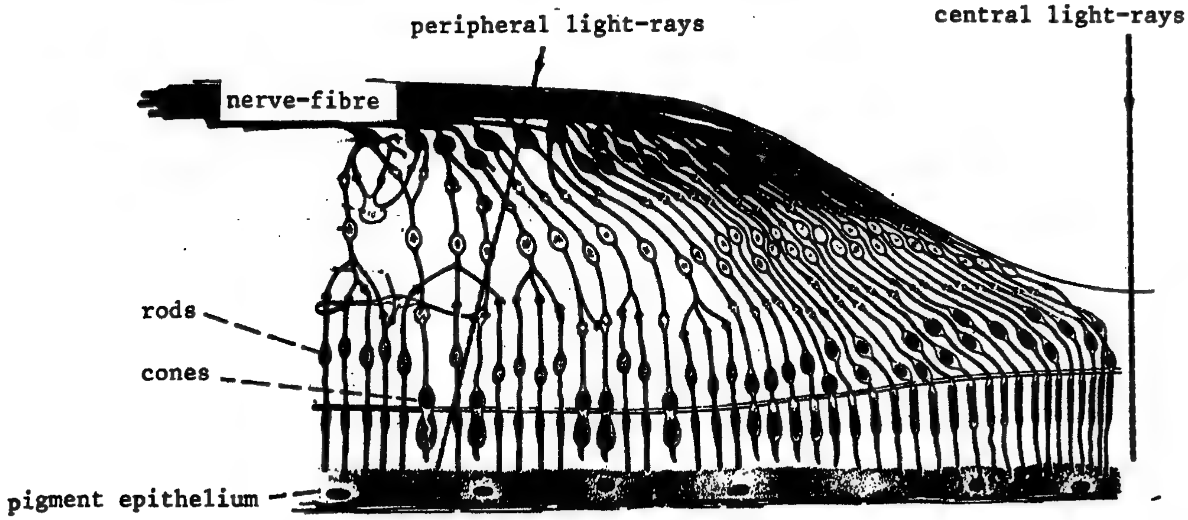
THE SIGHT-biological aspects



The sight is, however, extremely well developed. The visual field often ranges over 240° [11] and sometimes encompasses almost 360°. The lens of the eye is contained in the globe, and is usually adjusted to far distances. To notice objects close to the bird, it has to accomodate..

The retina, at the bottom of the globe, contains both rods, which are sensitive in darkness and three times as many as man has got, and cones, which work at daylight. The cones are responsible for the definition and colour sensitivity.

Each cone contains a coloured oil droplet, which among the gulls is red or yellow. The droplets filter the incoming light before it strikes the visual pigment, and it works like a "cut off" filter. This improves the discrimination ability, and makes it possible to perceive objects against a coloured background.



The retina

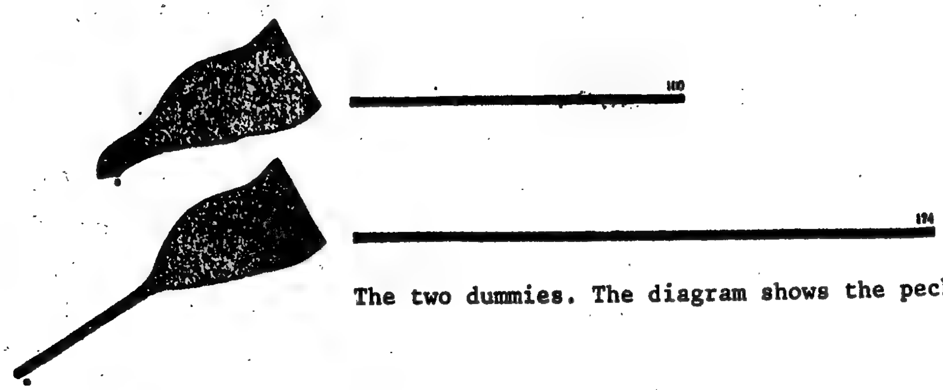
The rapid perception of quick movements to which a bird is able, is shown by the ability it has to perceive different pictures. A bird is capable of separating 150 pictures per second [11], while man can separate only 20-70. This makes it possible for the bird to discover even small movements of a prey in the field. A gull is, for example, able to perceive a movement caused by a mouse in a field just by a quick glance while flying over the area at a high altitude.

So far,only the eye itself has been concerned. But how does a bird react to objects of different forms? Do varying shapes elicit behaviours which could not be explained by simply adding the physical characteristics perceived by the eye?

SHAPE-DEPENDENT BEHAVIOUR

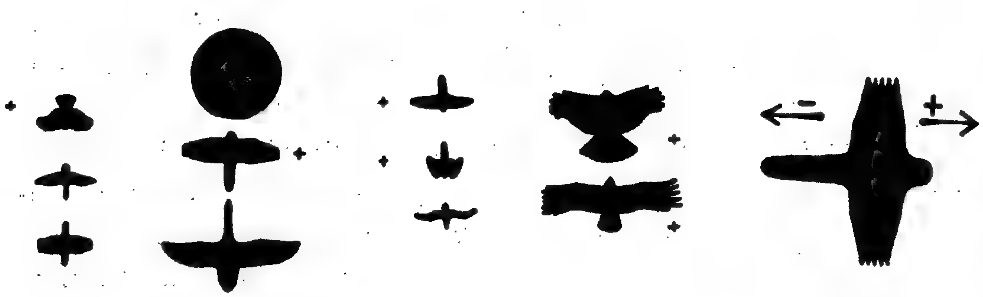
The answer is yes. Several experiments with gulls have shown that not only colour, movement and intensity of an object, but also its shape, play an important role in provoking a behaviour.

For example, experiments among gulls on this matter have shown [29] that the shape of a gull parent's bill and head is more important than its colour in starting the gull chick's inherited food begging when showing different models of gulls to the chick, it was shown that a one dimensional dummy, with an extraordinary long beak, far from being realistic, had a higher pecking rate than a realistic model.



The two dummies. The diagram shows the pecking rate.

It is also the shape (among other factors) that helps the gull to discriminate enemies from friends and chickens of their own brood from others. Konrad Lorenz's and Niko Tinbergen's experiments with geese and hens [29] also show how closely the behaviour of the gulls is related to the form of the object shown. When a paper dummy was flown over the birds in one direction, so sight of alarm could be noticed. But when taken in the opposite direction, it caused distress and fear among the geese and hens.



The + marked pictures aroused flight behaviour among the birds.

This shows the importance of taking not only the physical but also the psychological reactions of the birds into account.

But now, what results has research on the eye and brain of the birds come to? First the physiological aspect.

PREVIOUS RESEARCH concerning the PHYSIOLOGY of the EYE of the BIRD

a) The pupillomotor reaction as a function of wavelength

In 1923, Henry Laurens [15] performed experiments with pigeons to find out the correspondence between the pupillomotor reaction and light of different wavelengths. He equilibrated all colours to an equal amount of energy, and then he registered the response of the eye to different wavelengths. He found out that a maximum reaction occurred at λ=564.1nm (green) on a light-adapted eye.

This means that according to the pupillomotor reaction green appears to be the most effective colour.

Other parts of the eye which might affect the sensitivity to light are the visual pigment and of course the retina. First some results from experiments made on the visual pigment are related.

b) Visual pigment versus wavelength

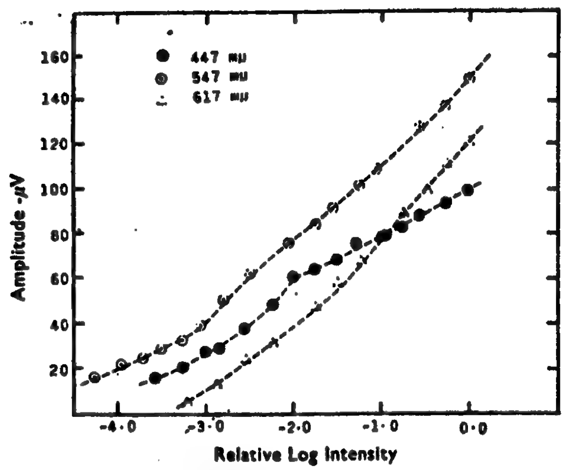
Crescitelli(mentioned in Sillman [25]) stated in 1958 that the visual pigment in the eye of the gull had a maximal absorption rate at a wavelength of 501nm (green/blue). The sensitivity of the visual pigment is interesting here, as it could help to indicate which colour birds are most sensitive to.

c) Signal amplitude in the retina as a function of wavelength

Physiological experiments made by Hisako Ikeda [12] in 1965 on pigeons showed that light of different wavelengths resulted in amplitudes of different magnitude, when measured by electroretinography in the retina (see the graph below). Ikeda examined the scotopic curve response in the rods in the retina of the pigeon, where the response was aroused at a low light intensity. The rods showed a similar absorption rate as that of rhodopsin.

Ikeda also measured the photopic spectral sensitivity (at constant illumination).

The scotopic curve reached a maximum at λ=502nm (green/blue), while the photopic curve reached its maximum at λ=544nm (green).



Relationship between the amplitude of the b-wave (the measured response in the retina, scotopic type) and the log intensity of the stimulus for different wavelengths.

Thus the rods, which are sensitive in darkness (see p 6), were according to the results of Ikedas experiments most sensitive to green/blue, while the cones were more sensitive to green.

CONCLUSIONS

These and other experiments, of which only a few are discussed here, have shown that due to the physiological sensitivity of the eye of the bird, its retina and visual pigment, green or green/blue seem to be most effective in causing maximal physiological response.

These experiments have all dealt with the reactions within the eye, excluding the psychological effect of the signals. As P. Nye [18], commenting the response in the retina to stimuli of different intensities and wavelengths, put it: ".. the wavelets (in the retina, my comment) are clearly visible when the eye has been isolated from the brain, and, therefore, they must originate within the eye itself."

Not only the reaction to light within the eye itself, but also the varying brain response to different colours and frequencies, is worth studying. Then, what research has been done concerning the physiological response in the brain of birds?

PREVIOUS RESEARCH concerning the brain of the bird

a) In Canada, Peter Belton [2] has performed experiments where he recorded the brain response to stroboscopic light on gulls. This was done by inserting electrodes into the brain, and then recording the brain responses by techniques of standard signal averaging. He found that the brain of the gulls showed maximal response to red (24% of the birds) and magenta (24%), and that yellow (20%) and white (13%) had a smaller response rate. The remaining 15% showed maximal response to green, blue or cyan. Totally 15 birds were examined.

Belton also tested the frequency response in the brain when the birds were exposed to light of different frequencies (2-60Hz). He noticed that the mean optimum driving frequency in the midbrain was about 9 Hz, while the forebrain was more active at lower frequencies.

These results contradict the ones from the eye experiments, as regards the bird's maximal physiological reactions to different colours. The sensitivity of the eye, examined physiologically, was (as mentioned before, see page 8) greatest to green or green/blue, while the brain response discussed here was maximal to red and magenta. However, all these experiments do not tell us anything about the scaring effect that light may have.

b) H. Samson and M. Young [24] in 1973 examined the relationship between the response in the midbrain (optic tectum) of pigeons to different flash intensities, when the background level of the light was varied. Their examination could therefore give useful information to what extent it is worth increasing the intensity of the light due to the bird's reaction.

In the experiment, the background level was altered from a very low level to a good interior lightning, while the flash intensity was varied from the strength of daylight to direct sunshine.

The results of the experiments showed that when the flash intensity increased, the peak-to-peak response amplitude in the brain also increased. When the background illumination became more intense, the peak-to-peak apmlitude decreased, as one could have expected.

Thus the changes in amplitude vary according to the contrast between background and stimulus, and the flash intensity influences the amplitude to a higher extent than the background level does.

Young and Samson also found that pupillary mechanisms seemed to have nothing to do with changes in waveform, latency or amplitude variations of the evoked potential in the brain.

As the results obtained in the experiments with the eye (maximal response to green/blue) seem to contradict the ones obtained in the brain examinations (maximal response to red and magenta), are there any field tests that can support any of the results and moreover tell us something about the emotional effects which light causes, such as fear, distress or alarm?

FIELD TESTS - psychological aspects

a) Field tests with stationary stroboscopic light of different colours and frequencies on gulls, have been carried out by Peter Belton, Canada [21]. He used incandescent and xenonfilled stroboscopic light, with energies ranging from 2 to 100 Wattsec, with or without red, green, blue, cyan, magenta or yellow broadband filters. No information about the distance to the gulls was given.

The results of the experiments show that although most birds looked towards the light source when exposed to the beam, they could not be dispersed from the fields by using light. Neither could any sign of distress or alarm among the gulls be noticed when using the strobe.

Peter Belton also compared the time it took the gulls to arrive at a feeding station with and without light from an aircraft strobe. When using the strobe (unfiltered or magenta flash at 2/sec), a delay of the arrival of 30-45 minutes could be noticed.

b) To find out if light could be used to frighten birds, test has been made by Marc Laty, France [13]. He performed experiments with flashing light on gulls at a household refuse tip. He used strobes similar to the ones on aircrafts, with energies of 1.5 Watts. The colours blue, red and white were tested by means of different filters.

Laty's results showed that when blue light was used, the gulls flew off at a distance not exeeding 40 metres, while red and white light was less efficient. The flash frequency had then not to exceed 100 cycles per second.

These reults, discussed above, are all based on daytime observations. Is there any difference then in the birds' behaviour when exposed to light at night?

LIGHT ON BIRDS AT NIGHT

Griffin, Larkin and Toree-Bueno [8] have studied variations in the pattern of behaviour of birds when exposed to light at night. They made the observations from a tower, and used a small ceilometer lamp (300W), with a beam width of a few degrees, and detected the birds by radar. When the birds were at a distance of 250-500 metres, at an altitude of 100m, the light was turned on and the reactions it elicited were observed.

Most birds - two thirds of a number of 95 cases - modified their flight pattern within a few seconds after that the light was switched on. Approximately 50% of the birds which reacted, showed quick turning movements within half a second after being illuminated.

Other observations of birds' ways of reacting to light at night when flying near illuminated buildings, have been made by Rybak, Jackson and Vessey [22]. Their study shows that bright light at night seems to attract migrating birds, especially under adverse weather conditions. As an example can be mentioned that when Perry International Monument on South Bass Island was illuminated with flood light, hundreds of birds were killed on a single night by colliding with the monument. Once about 80 birds were injured or killed within 15 minutes when light was on, compared to minimal mortalities when no night lighting was used.

CONCLUSIONS

Both the physiological and psychological experiments with light on birds show that light to a certain extent does have effects on birds and their behaviour.

Light also has advantages due to the possibility of using it on aircrafts as it is relatively easy to attach on a plane at a reasonable cost. At present many airline companies already use lights at daytime to prevent bird strikes.

The matter of avoiding a collision between a bird and an airplane has mainly two aspects; one being that the bird should be able to detect the plane in time to be able to escape quickly, and the other that the bird must consider the aircraft dangerous and therefore fly away.

Using light would help the bird to detect the plane earlier and possibly give it an impression of danger as well. This will speed up the evasive manoeuvers which the birds may perform after having discovered the plane.

These are the reasons why light could be suitable in order to reduce birdstrikes, and this also forms the theoretical background to the experiments with light on birds which will be discussed below.

EXPERIMENTAL BACKGROUND

The birds' sensitivity to light, the great amount of varying possibilities and the easiness to attach light to aircrafts, made light a suitable choice for achieving a deterrent effect on the gulls.

Light can be varied in many ways, a few of these being:

a) colour
b) intensity (energy)
c) pattern which can be formed by the light
d) frequency

Due to the shape-dependent behaviour among the birds (see page 7) and their fear of birds of prey, the first step would be to try to achieve a deterrent birdlike symbol and then to use light in order to imitate this shape.

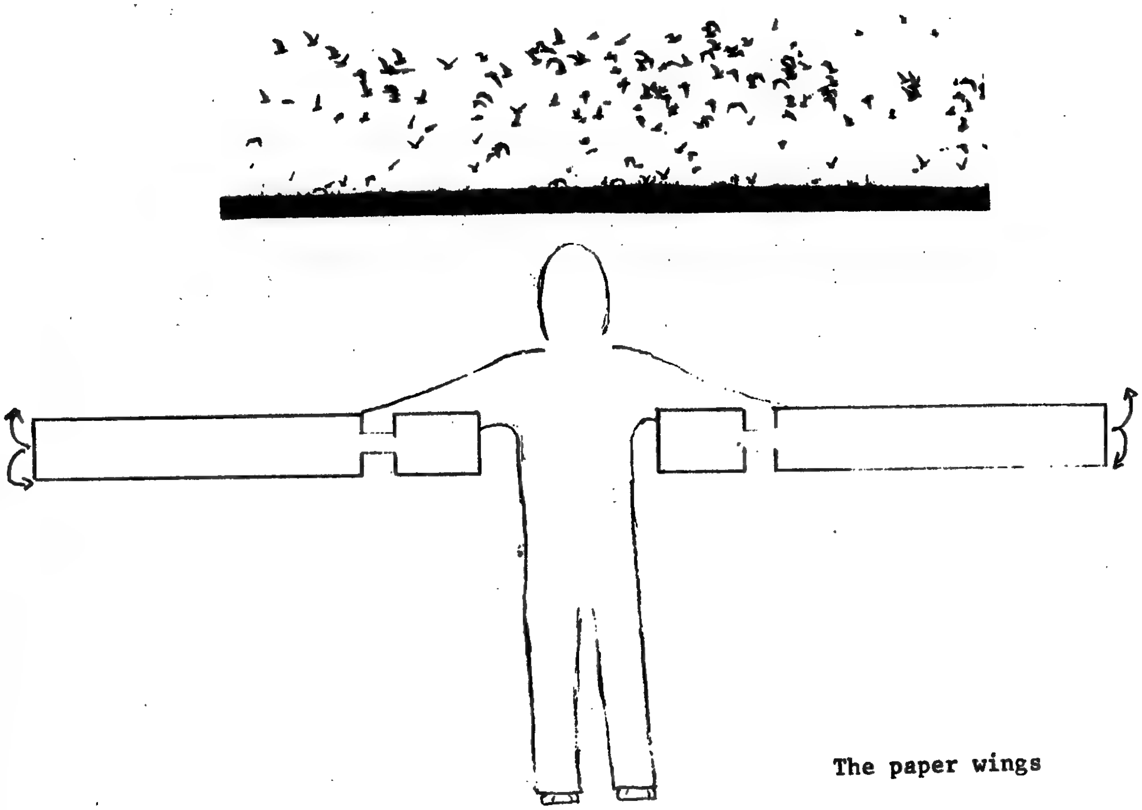
EXPERIMENTS - IMPLEMENTATION

PAPER WINGS - FRIGHTENTING IMPRESSION

A pair of "paper wings", two 1.6 x 0.18 m^2 paper plates, painted in different colours, were made in order to investigate the shape and colour dependent behaviour among the birds. The effect on the gulls was tested out in the vicinity of Stockholm on a household refuse tip with hundreds of gulls.

The experiments were performed in the following way:

A person went slowly towards the gulls, which were sitting eating on the ground in hundreds, and flapped with the "wings" slowly back and forth in the horizontal plane. The different distances at which the birds flew off were recorded and used as indications of the scaring efficiency which the wings had on the gulls. The results were then compared to the ones achieved in experiments without wings (reference tests). It was found that the wings and through them the symbolic impression did have an effect on the gulls (see page 17).



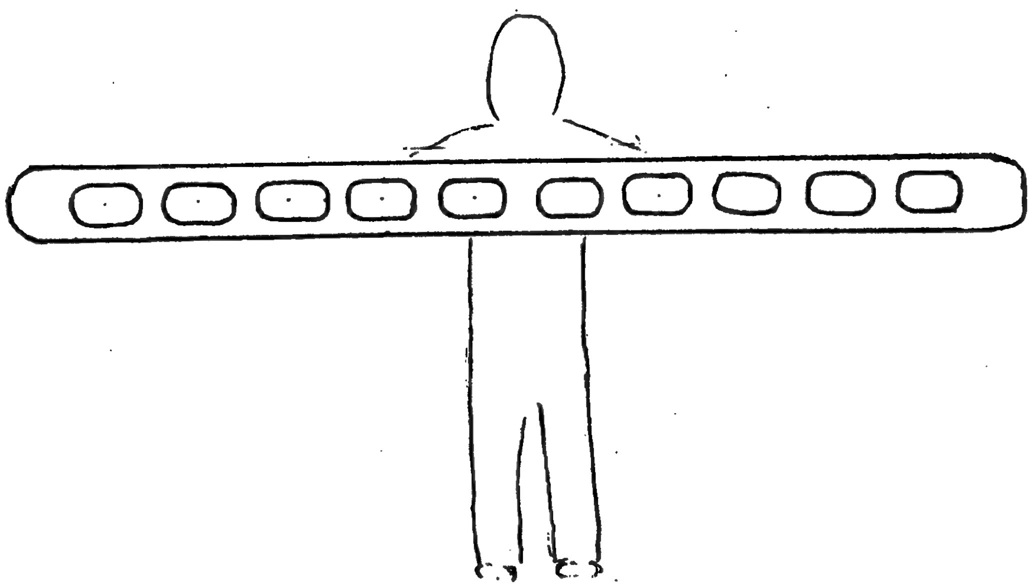
The paper wings

FRIGHTENING IMPRESSION BY LIGHT

The next step was then to construct something that used light in order to achieve this flapping impression which the birds were afraid

of without a person's mechanical waving with the paperwings.

A 3 x 0.15 m^2 board, with 10 ordinary carlamps (each at 21 W) mounted on it, was built up. The lamps could be set to twinkle at different frequencies two by two (ranging from 0.1 to 4 Hz, 0.75 Hz was used in the experiments) so that a sweeping, "flapping" impression in the horizontal plane was obtained. This light ramp was first mounted at a car, and then carried by a person. The scaring effect of it was tested out in a similar way as in the experiments with the paper wings. The scaring distance was measured for the lighted ramp and compared to the results achieved with the unlit ramp and a reference. The reference here was the same as the one used in the paperwing experiment; that is the result obtained when a person without equipment approached the gulls.



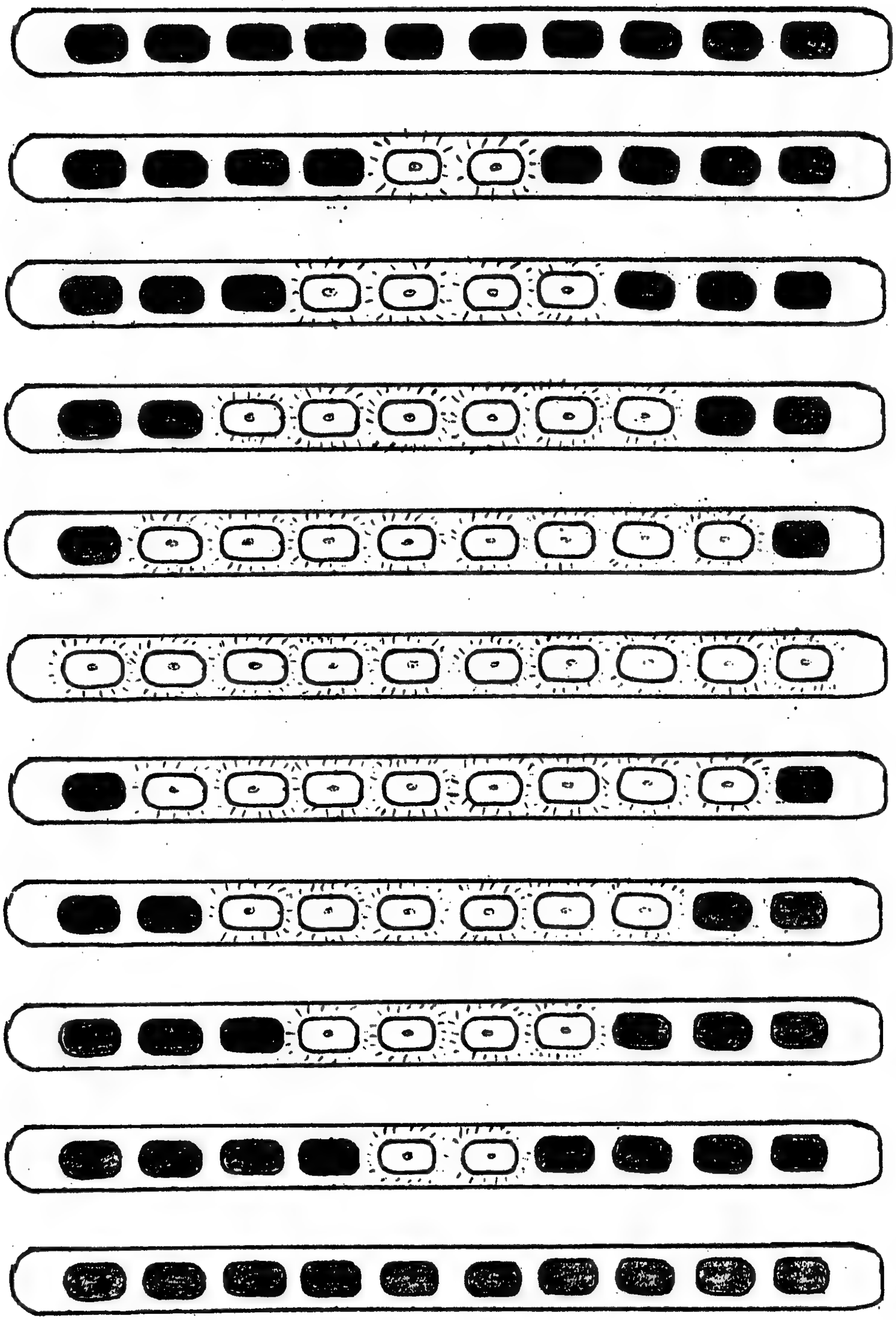
The light ramp and the way it was carried. The propagation of the light during one period is shown on next page.

RESULTS

a) paper wings - symbolic impression

When the scaring effect through the symbolic impression caused by the

The light propagation by the ramp.



paper wings was recorded by means of noticing the different scaring distances, it was evident that the wings did have an effect. The difference between the figures obtained with the wings and in the reference test, was statistically significant both at a 90% and at a 95% level (see appendix 11).

If a comparison between the confidence intervals (see appendix 11) for the different colours was made, a variation in scaring effect could be noticed. Blue had the longest alarm distance, followed by red, white, green and yellow. Due to the broadness of the intervals, it is difficult to point out blue as more efficient than for example red. Obviously, however, yellow is less scaring than both blue, green, red and white, and the next less effective colour seems to be green.

	BLUE	GREEN	YELLOW	RED	WHITE	REFERENCE
n	10	10	17 (14)	10	12	20
$\bar{m}$	58.3	53.5	46.6(50.4)	57.4	56.1	41.2
s	7.1	2.9	9.1 (4)	9.3	6.7	8.7
Md	57.5	55	50 (50.5)	55.5	55	40

The table shows the results of the paperwing experiment, measured in scaring distance (meter).

n: number of experiments
s: standard deviation
$\bar{m}$: arithmetic mean
Md: median

These results seem to contradict the ones obtained in the experiments with the retinal sensitivity and the pupillomotor reaction, which both pointed out green as the most efficient colour. On the other hand, P. Belton's brain experiment pointed out red, and M. Laty's field test blue as the most efficient colour, in agreement with the results obtained here.

It is to be assumed that red or blue seem to be more alarming to the gulls than green or yellow, which both occur frequently in nature, and therefore do not appear as dangerous as the more rare ones. Flapping green objects must be familiar to the birds, which are used to moving leaves in the trees. Yellow represents the colour of sunshine, which also varies in intensity in nature, and therefore probably is less frightening to the gulls.

b) light ramp -symbolic impression

The results obtained in the experiments with the light ramp show shorter scaring distances than the ones achieved in the wing experiments. Both white and blue light were tested. (The blue colour was achieved by covering the board with blue, transparent plastic). For each experiment with light, a rest with the ramp unlit was performed. This was done in order to find out to what extent the shape of the ramp influenced the results.

	WHITE LIT	WHITE REF	BLUE LIT	BLUE REF	WHITE ON CAR	REFERENCE
n	11	18	14	13	9	20
$\bar{m}$	49.5	44,1	33,6	47.8	6.1	41.2
s	18.9	14.4	10.5	3.1	5.8	8.7
Md	50	38.5	36.5	48	7	40

The table shows the results of the experiments with light, measured in scaring distance (meter). n, $\bar{m}$, s and Md as in the table on page 17.

The results showed, however, no statistical significant difference neither between the lit ramp with white light and its two references (the unlit ramp and the reference used in the paper wing experiment), nor between the two references.

The experiment with the blue light showed however, a peculiar result. The lit light ramp showed less efficiency than only the ramp (with blue plastic on) did! This is probably explained by the circumstances during the experiment. A gale blew during the week when the blue reference was tested, and the stormy weather made the gulls remain sitting to a greater extent than under normal conditions.

The difference in results between the blue reference and the white one was not significant in this experiment, contradicting the results from the paper wing experiment, where the colour blue was more efficient than white.

c) light ramp on a car

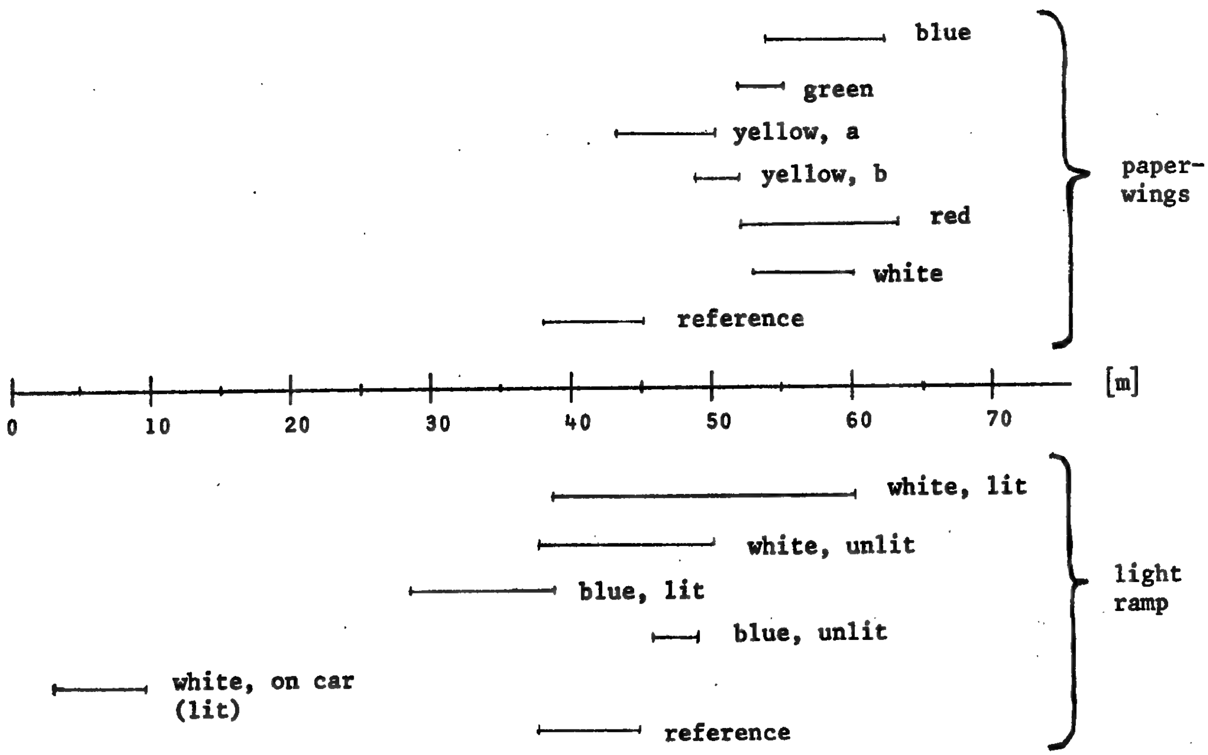
To test the effect of varying silhouettes in the experiments, the light ramp was also attached to the roof of a car. It was driven slowly towards the sitting gulls in a similar way to the previous tests with a person.

The distance at which the gulls flew off was very short indeed when using the car, much less than the results noticed when using a reference. One reason for this could be that the ramp mounted on the roof of the car formed another silhouette against the background than the ramp carried by a person approaching the gulls.

This seems however, to disagree with the nonsignificant difference between the experiments with the unlit ramp (silhouette T) and the reference one, the single person (silhouette I).

Another explanation is that the lamps were put at another height when being mounted on the car, and that this influenced the bird's discovery possibility. This seems to contradict the fact that the gulls have an extremely good sight and rapid perception ability. Finally the birds could be more used to cars in general than to persons, but this seems very unlikely.

If these results hold for true, the use of light in this experiment had no effect on the behaviour of the birds.



Confidence intervals for the experiments with light and colour (paper wings). At a 10% level (see appendix II).

IMPERFECTIONS DUE TO UNCONTROLLABLE FACTORS

Always when one has to perform experiments in an environment that could not be properly controlled, measurement uncertainties arise. As the experiments have been made at a household refuse tip with normal activity, some factors that could have influenced the flight willingness among the gulls are :

a) The supply and art of food at the tip (weekly variation)
b) Sounds and movements caused by dustmen and lorries
c) Varying weather
d) Habituation to equipment
e) Association of a general danger with the person who made the experiments.

As these factors all could have influenced the results to a certain extent, an effort was made to eliminate as many as possible of them. Instead of performing long experimental series with one colour at a time, an exchange of colours was done in order to achieve similar circumstancies for the experiments. This decreased the effect of the bird's familiarity with the equipment and the colour, and also decreased the influence of the other factors. The impact of these disturbances on the results is, however, difficult to estimate in meters.

MEASUREMENT IMPERFECTIONS

The fact that the flock of birds often changed shape, made it difficult to estimate a "middle" point of the flock. Instead the distance to the front birds was noted as scaring distance, supposing that the nearest birds also flew off earlier than the ones at a longer distance. This was not always the case, and this caused an underestimation of the scaring effect.

All experiments were also performed on eating gulls, which were sitting on the ground. This again leads to an underestimation of the effect that the wings and the light may have on flying birds.

CONCLUSIONS

The experiments with the paperwings show that a continous, rapid movement in the horizontal plane elicit a flight behaviour among the gulls. When compared to the results obtained by the reference, (a person without any equipment, walking towards the birds) a statistically significant difference was achieved.

Due to the colour dependent behaviour of the gulls, there seem to be a variation in the strength of the flight readiness among the birds. Here the confidence intervals for the means are too broad (see page 20) to allow any ranging among the colours red, blue and white, but yellow seems to have a less frightening effect than the other colours. Green shows a slightly better result than yellow, but not as good as the others do.

It is, however, difficult to conclude that the sweeping light experiments were very successful. The results did not differ significantly from the reference ones, and the ramp on the car showed almost no scaring effect at all.

Probably the imitation of the wings through the ramp was too bad, likely due to the point-like placing of the lamps on the ramp. (See page 16). An improvement could therefore be to construct a similar equipment as the ramp but with continuous light propagation, to obtain a more flapping impression.

LASER AS A LIGHT SOURCE

So far,only ordinary light and its efficiency on birds has been taken into account. Ordinary light has, however, disadvantages, one of them being the divergence of the light, which decreases its effect at far distances. Then, how can a long effective distance be achieved when light is used?

One way of obtaining this is to use a laser as a light source. A laser delivers coherent, monochromatic light with high intensity, which diverges very little.

This makes it possible to choose a suitable wavelength of the laser light due to the optimal sensitivity and reaction readiness of the birds. As a laser also increases the effective distance due to its low divergence, it seems well adapted for using on aircrafts. The long range of the beam will give the birds time to discover the plane earlier, and possibly elicit an avoidance response among them as well.

What type of laser is then suitable to applicate at an aircraft?

CHOICE OF LASER

When choosing a suitable laser for the purpose of scaring birds, several aspects must be taken into account.

The laser for this purpose must, of course, deliver light of a wavelength that the birds are sensitive to. Not less important are however, the operational conditions that the laser may require, as power and water cooling. The size of it, its stability and what output power it gives in return are also important here.

Today, there are a lot of different kinds of lasers available for this purpose. According to material, construction etc the lasers could be divided into five main groups, [34], [35], [39] namely:

Gas lasers — which split into neutral atom lasers, with wavelengths in the visible and IR-region (ex He-Ne, $\lambda = 632.8$ nm of 1-50 mW), ionlasers, as the Ar (ex λ = 488 nm, 514.5 nm) and the He-Cd (available wavelengths 325, 441.6 (blue), which both often require high power, and finally the molecule lasers, in the far infrared region, as CO_2 (λ = 10,6 µm, 1-1000 W) and in UV, N_2 (λ =337.1 nm), which often require water cooling.

Crystal- and glass lasers, or optically pumped solid state lasers, are in most cases pulsed and deliver less coherent light than the gas lasers do. Here the Ruby laser (λ = 694.3 nm, 1-1000 W) could serve as an example for the group.

Dye lasers, with fluorescent organic dyes, are also often pulsed, with wavelengths in the region λ = 350 - 1170 nm.

<u>Semiconductor Diode Lasers</u>, finally, also deliver less coherent light than the gas lasers, and could also be used in room-temperature.

Here the gas lasers are of special interest, and will be studied more in detail.

A gas laser could contain varying gases; noble gases as Helium, Neon, Argon, Krypton and Xenon, halogens, as Chlorine, Bromine and Iodine or some other kind of gas. The choice of gas, among other factors, determines the properties of the laser.

Two-ion lasers, which are different from each other in a representative way within the group, are the Helium-Neon (He-Ne) laser and the Argon (Ar) one.

If a comparison between them through the specifications of the different models 124 A He-Ne and 164-06-Ar from Spectra Physics are made, they will be found to differ a lot from each other.

The Argon laser, to start with, has power requirements of 13 100 W and must be cooled by a constant water flow of 8.4 litres/minute. The weight of it is 105 kg, and the output effect is 2 W (for multilines; λ = 457.9-514.5nm).

The Helium-Neon one has power requirements of approximately 200 W, and weighs 10 kg. It does not require any water cooling. The wavelength of it is λ = 632.8 nm, and the output effect is 15 mW at that wavelength.

This brief comparison, through the specifications of the lasers, points out the He-Ne laser as the most suitable one for bird strike purpose due to its lower power requirements.and the fact that it does not need water cooling.

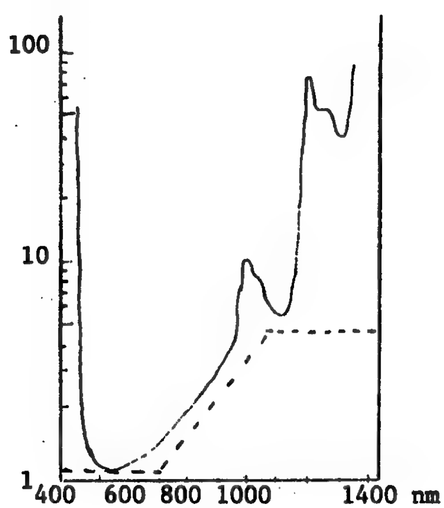
Also the wavelength of the He-Ne laser(λ = 632,8 nm red)seems to be suitable to use on birds due to their brain responses to that colour (see page 10). This suggests that a laser of for example He-Ne-type may be suitable as an instrument to reduce bird strikes. Lasers in general should, however, as all strong light sources, be handled with care as the direct light could be hazardous to the eyes. Then - to what extent could light from lasers be considered harmful?

LASER SAFETY

All high intensity light sources, as projector lamps and the sun, could be hazardous to the eyes. What makes the light of the laser so special is its properies of being intense, coherent and parallel. This means, that the lens of the eye will focus the rays to small spot on the retina, where the energy will be absorbed.

If the time for the exposure is short [38], [39], less than µs (10^{-6}s), mechanical harm in the eye as after a microexplosion will be the result of the light. If the duration is about a ms (10^{-3}s), then the energy of the light will heat up the tissues in the eye which could cause part of the retina to coagulate, and therefore destroy the receptors there. The thermal process could also cause bleedings in the tissues. Both these processes will result in a loss of definition. Finally, if the exposure is of the magnitude minutes to hours, photochemical reactions in the eye will be the result.

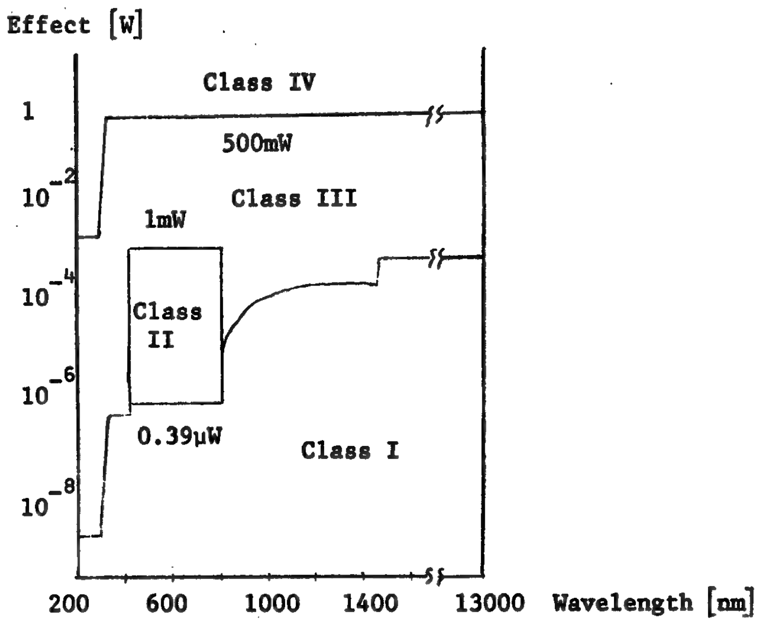
The hazard of the light depends not only on the time of the exposure, but also on the wavelength of the light. The cornea and the lens transmit light in the region 0.45-1µm [35], but absorbe to over 99% the wavelengths longer than 1.5 µm and from 0.3-0.35 µm.



The rate of relative reduction for the transmission of light of different wavelengths to the retina [39].

As the reaction in the eye to the light depends on wavelength, power coherence etc, a classification of lasers according to their harmfulness has been made [30]. The lasers are diveded into four categories, class I - IV.

A class I laser is considered to be incapable of producing damaging radiation levels. A class II laser, a low power system, may be viewed directly under carefully controlled exposure conditions. For lasers belonging to class III, a medium power system, watching the direct beam must be avoided. Finally for class IV lasers both exposure of the eye and skin to the direct and diffusely reflected beam must be prevented.



Classification of continuous lasers due to their relative hazard [39].

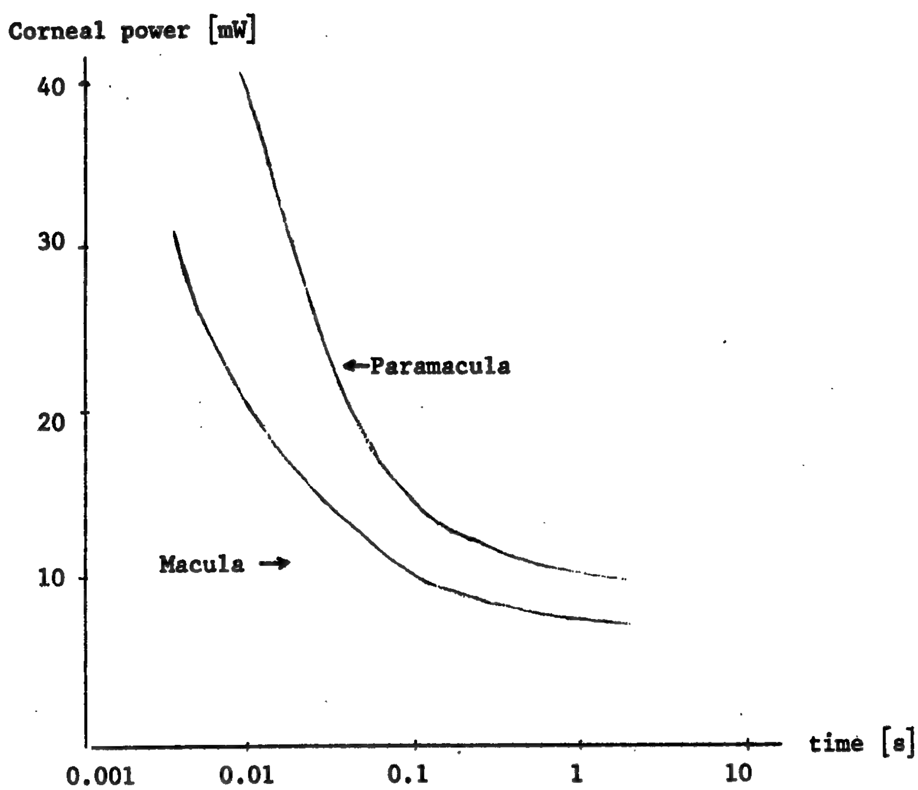
A Typical Classification for Continuous-Wave Lasers, the Ar and He-Ne ones [30].

Laser	class I	class II	class III	class IV
argon	$\leq 0.4 . 10^{-6}$W	> class I	> class II	> 0.5 W
He-Ne	$\leq 0.4 . 10^{[15(\lambda-0.55)]}$ λ i μm	but $\leq 10^{-3}$ W	but $\leq$ 0.5 W	

The criteria for the maximum exposure of the eyes and the skin that are below hazardous levels, is the maximum permissable exposure, MPE [30] values (exposure = irradiance x duration). The MPE for direct ocular exposure, intrabeam viewing, from a laser depends on wavelength and exposure duration. If, as an example, a person would look into the beam of a He-Ne laser of 30 mW for 10 seconds (7 mm limiting aperture), the MPE value will be about 10 m J/cm^2 = 10 mWs/cm^2 [30]. For the He-Ne laser, that MPE value corresponds to a person's staring directly into the beam for 10 seconds at a distance of 60 meter.

For viewing a diffuse reflection at a beam, the corresponding MPE value is (for 10 s looking) 22 J/cm^2sr (1 mm limiting aperture).

The MPE values are, among other factors, based on experiments made on animals. Here a study on monkeys on the effect of laser light showed that (see below) at about one second, the median power to produce a minimally observable lesion was about 8 m W [36].



Median power to produce minimally detectable lesion on Rhesus monkeys' eye as a function of time exposure (logaritmic scale)[36].

Human data seem to indicate a reduction of the sensitivity of the eye to the light by a factor 2 or 3 compared to the eyes of the monkeys [33],[37].

Has there then been any research which has investigated the effect of laser on birds?

PREVIOUS RESEARCH ON LASER ON BIRDS

Sheldon Lustick [16], at Ohio State University, in 1973 investigated the effect of light from argon lasers (both continuous and pulsing) on gulls, starlings and mallard ducks. He measured the activity and the avoidance response which the light elicited among the birds and the heart rate on the birds when exposed to the laser beam. The intensity of the laser was varied, during the experiment, as was the wavelength (488-514 nm), and the beam could be concentrated or expanded by using a telescope.

The table below shows the mean time it took mallard ducks to show an avoidance response when exposed to the laser light. Here it could be seen that the light elicits an avoidance behaviour faster if more power is set on the laser.

Table 4. Mean time to avoidance in Mallard ducks exposed to various laser light ranges under simulated daylight (sec.)

Diameter of Beam on Target (cm)	0.05	0.5	1.0	2.0	3.0	2.0 Pulsing
0.2-0.5	10.2	6.7 ± 2.7	9.0 ± 4.6	2.8 ± 2.4	15	5.7 ± 2.1
5.0	22.0	33.3 ± 6.5	24.3 ± 6	16.6 ± 2.6	0.0	15.8 ± 2.0
10.0	--	9.3	9.6 ± 1.9	16.3 ± 4.6	18.8 ± 3.7	9.9 ± 2.1
15.0	--	--	28.4	23.7 ± 7	15.2	28.9 ± 6.3
35.0	--	--	--	--	16.5	--

Means are ± one standard error of the mean.
Only birds eliciting an avoidance response are included in the mean values.

The results with a concentrated beam of at least 0,5 W on gulls showed that the laser elicited an avoidance response wherever it hit the bird, and that no habituation could be noticed.

When Lustick used an expanded beam, the ray seemed to irritate the gulls exposed to it. A behavioural response of head-shakings and eye-rubbings could then be noticed. The gulls could, however, look into the beam without showing any avoidance response.

The table below shows how many gulls (in percent) that reacted to the light with an avoidance behaviour. When, for example, the power set on the laser was 1 W, with a diameter of the beam of 0.2 - 0.5 cm, 91.5 % of the gulls used in the experiments avoided the light.

Table 5. Percent of the gulls avoiding laser light of different intensities

Diameter of Beam on Target (cm)	Power Setting on Laser (W)					
	0.05	0.5	1.0	2.0	3.0	2.0 pulsing
0.2-0.5	8.3	69.3	91.5	85	71.3	89.5
1.0	0	12.5	25	55.6	37.5	16.7
2.0	0.0	10	37.2	33	17.7	0.0
5.0	0.0	0.0	14.3	8.3	0.0	6.2
10.0	0.0	0.0	0.0	0.0	0.0	0.0
15.0	0.0	0.0	0.0	0.0	0.0	0.0

Lustick's experiments show that a laser with an effect of at least 0.5W and with a concentrated beam, elicits an avoidance behaviour amoung the gulls.

Marc Laty, France, [14] has also recently tested the effect of laser light on gulls at a household refuse tip and noticed some effect of the laser on the birds.

As the use of a laser on birds to reduce bird strikes is a fairly new applicational area, the number of experiments which has been made are quite few.

LASER EXPERIMENT

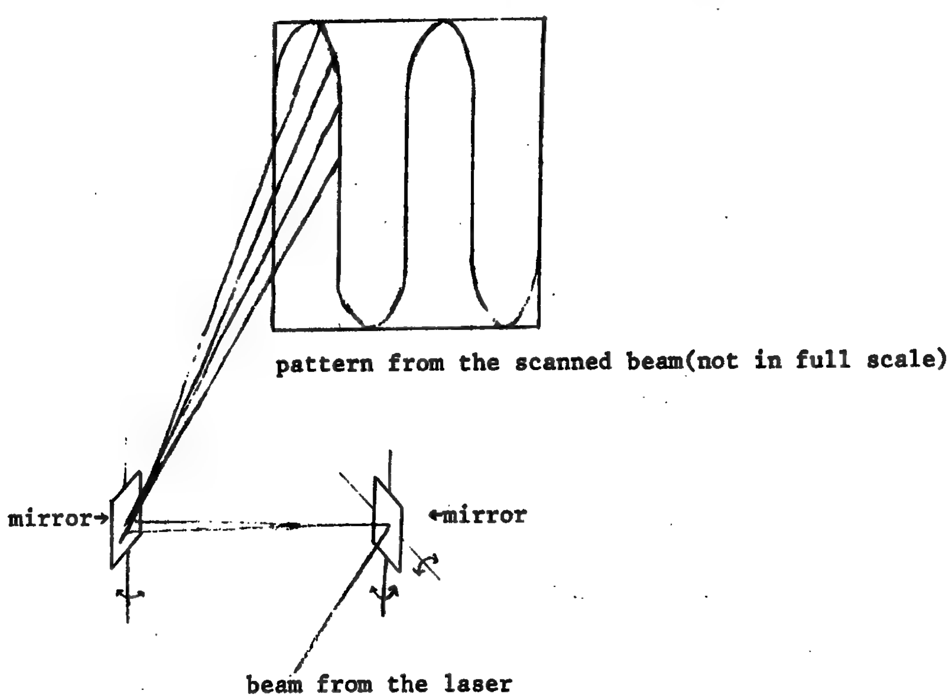
As the experiments related above show, the laser seems to have an effect on birds. Then, how do birds in freedom react to laser and

to what extant does the beam frighten them?

In order to investigate the deterrent effect of a laser on gulls, experiments were made on hundreds of gulls (most seagulls) on a houshold refuse tip. As it is difficult to illuminate the birds when they are flying (aiming problems) and as such an experiment will be influenced by uncontrollable factors and suffer from measurement problems, the reactions of the birds to the laser were tested out in food experiments.

A continuous helium-neon laser (λ=632.8 nm) of 30 mW was used to illuminate one of two identical flat basins, 30 x 30 cm^2, each filled with two buckets of fish guts. The two fish filled bowls were put at a distance of 20 metres away from the laser, which was kept in a car (rainy weather). One of the bowls was illuminated either by a concentrated or a scanning beam, while the other one served as a reference. The number of occasions when the gulls preferred to eat from one of them were recorded and the results compared.

An expansion of the beam was achieved by using two mirrors, which could be set in motion with different frequencies and through this make the beam scan over a rectangular area.



Here the sweep frequencies were 9 Hz in the x-direction and 100 Hz in the y-direction, which means that a light flash will hit the eye 9 times per second. That particular frequency had shown to be most efficient due to earlier experiments on gulls (see page 10).

Table: Irradiance and area of the beam (concentrated) at the target as a function of distance

distance (m)	diameter of beam (cm)	area of beam (cm^2)	irradiance (W/m^2)
10	1	0,97	310
20	2	3,5	90
50	5	20,5	15
100	10	80,3	4
1000	100	7871	0,04

As a comparison could be mentioned that the irradiance of a car headlight is less than 1 W/m^2.

RESULTS

It was found that when the concentrated beam illuminated one of the bowls, a statistically significant difference (chi-square test, see appendix II) at a 90% level between the preferences of the bowls was recorded. In 8 cases out of 11, the reference bowl (which was not illuminated) was preferred to the laser illuminated one (see next page).

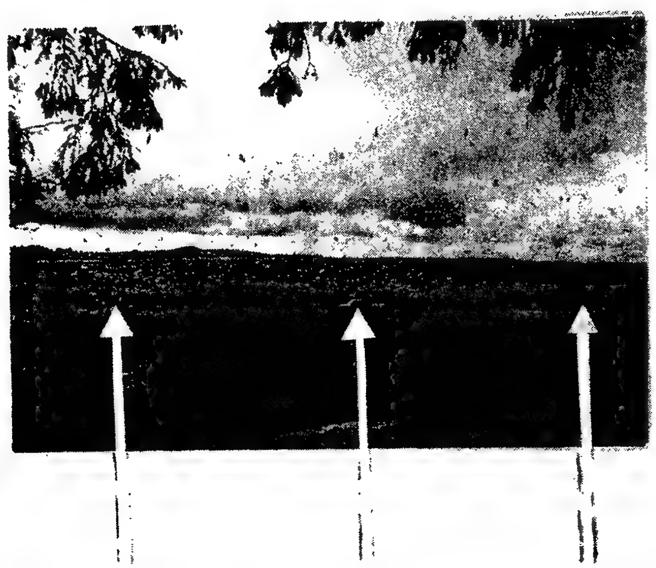
In the majority of the experiments, however, the repellance of the laser beam was not strong enough to restrain the birds from eating the fish, even if time delays of the eating of at least one hour could be noticed.

Eating at the laser bowl, concentrated beam. Laser to the left.

When an expanded beam was used, no significant difference between the preference to any of the bowls was noticed. Another pattern of behaviour was,however, shown in this experiment. Several times the gulls arrived at the illuminated fish-filled bowl, and then they could sit staring there at the laser, without eating, for an hour. Then they could, all of a sudden, start eating without noticing the beam at all.

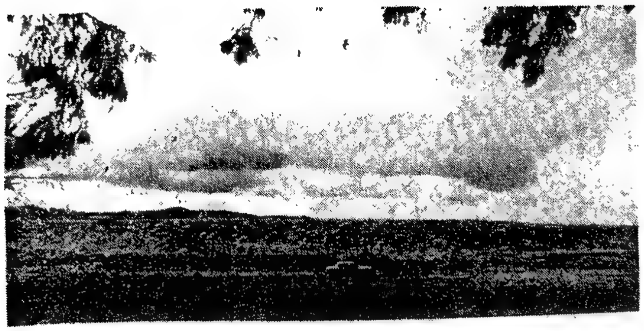
Staring behaviour, expanded beam. Laser to the left.

On the next page, some photographs taken in the order 1,2,3 etc from an experiment with the laser; concentrated beam are shown. As the photo below shows, the bowl to the left is the reference one; the one to the right is the illuminated bowl. The photos show how the gulls at first prefer to eat from the reference bowl, and then how they fly to the illuminated one when they have finished the reference bowl. The car on the picture contains the laser.



Reference bowl   Laser   Laser illuminated bowl

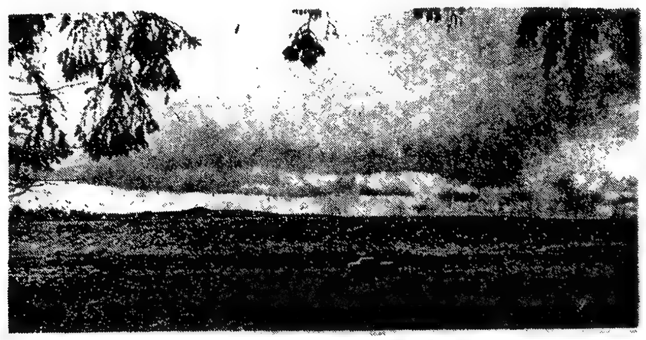
The lack of preference to any of the bowls in this experiment could probably be explained by the difference in effect per area-unit between the two experiments. When using a concentrated beam at a distance of 20 metres, the beam covered an area of $\sim 3,5\ cm^2$ above the bowl, while the expanded beam at the same distance covered an area of $\sim 0,35\ m^2$.



Nr 1

Nr 2

Nr 3



Nr 4

Nr 5

Nr 6

Nr 7

Nr 8

	concentrated beam		expanded beam	
first choice of bowl:	illuminated bowl	reference bowl	illuminated bowl	reference bowl
	18% (2)	73% (8)[x]	58% (7)	42% (5)
delay of eating (more than an hour)	36% (4 of 11)	0	17% (2 of 12)	25% (3 of 12)
total numbers of experiment	n = 11		n = 12	

x) In one of the experiments the approach was simultaneous to the reference bowl and the illuminated one.

IMPERFECTIONS DUE TO UNCONTROLLABLE FACTORS

As the experiments with the laser were performed at a remote part of the household refuse tip, and as a reference was used all the time, the number of uncontrollable factors are reduced here. But still factors that influence the results could be:

a) Varying weather
b) The supply and art of food at the tip (degree of hunger)
c) Habituation to equipment (could not be noticed)

CONCLUSIONS

Both the experiment with the concentrated beam and the one with an expanded beam show that the gulls do notice the laser beam. When using a concentrated beam, the light also elicited an avoidance behaviour, though the frightening effect was not strong enough to restrain the birds completely from eating.

The power of the laser used in the experiments was however quite low, 30 mW, and of course an increase in the effect also increases the repellance the light has on the gulls (see Lustick's experiments). The effect of the laser must, however, be balanced to the risk of causing damage to the eye of man (see page 26).

FRIGHTENING BIRDS WITH SYMBOLIC LIGHT OR LASER - A COMPARISON

As the experiments with light and laser in most cases have been made in different ways, it is difficult to compare the efficiency of the two methods based only on the results from the experiments. But some general advantages and disadvantages with the two methods will now be discussed.

The use of light in general, carried by aircrafts, works in two different ways on birds. Firstly the light increases the distance at which the bird will catch sight of the plane. Secondly the light should make the bird escape quicker and possibly through that prevent a collision.

If only the aspect of earlier detection is taken into account, the laser seems to be most efficient due to its long effective distance and its low divergence. Experiments also show that when exposed to the beam, the birds noticed it.

If then the frightening effect of the two methods is compared, which one is to be preferred?

The laser has a frightening effect mainly through its concentrated beam, into which it is unpleasant to look. Lustick's experiment showed (see page 28) that the birds found the beam irritating when exposed to the laser, and that the light elicited an avoidance behaviour among them. The food experiments on the household refuse tip also showed that the birds rather avoided the laserilluminated food.

An increase in the power of the laser would here also increase the effect it has on the gulls (see Lustick), but here the possibility of a

prevention of a bird/aircraft collision must be balanced to the risk of causing eye damage to the human eye (see page 25).

The frightening effect which ordinary light itself has on gulls is not very great. As Peter Belton's experiments with light showed (page 10), most birds noticed the light but it did not cause alarm or fear among them.

The colour of the light also influences the effect it has on birds. Blue has been found to have a strong frightening effect (Laty, see page 12) as have white and red (see page 17).

The alarming effect can also be improved, if the light can be used for achieving a symbolic impression of something to which a bird reacts instinctively with fear.

Such an object is a bird of prey, and when an imitation of such a bird's way of flying (see page 15) was made (moving "paperwings"), it frightened the gulls on which it was tested.

The imitation of the paper wings by light, however, was not very successful (see page 16B)but several improvements of the equipment can be made.

TECHNICAL IMPROVEMENT

As the laser seemed to have an effect on the gulls, are there any way of obtaining results without using very high energies?

It is possible to construct a selective system using laser, which detects objects in front of the aircraft, for this purpose. Then the space in front of the aircraft could be scanned by noticing the reflection of a signal, and the results could be shown on a television screen. If birds are detected in front of the plane, an automatical aiming system could be used to put the laser beam into position so that only the desired object (the bird) will be exposed to the beam. When a flock of birds is in front of the plane, an expanded, scanning beam could be used instead. This technique is already used for detecting aircrafts, and has been used in several military applications [31].

Of course, still care must be taken at take off or at landing, so that no harm will be done to the human eye (see page 25), but using a low-power laser in this selective type of system decreases the risk considerably.

Ordinary light equipment could here be used either in a combination with the laser, or separately. Then a continuous - as "flapping"-like as possible - light propagation will be desired, with as low divergence and with as high effect as possible.

It is also possible to achieve this continuously spread, flapping light movement by illuminating the wings with a rotating light source with high effect. The reflexion would then elicit an avoidance behaviour among the gulls, as the paper wings did (see page 17).

The methods discussed above could hopefully help to reduce the bird strike rate. However, still further research has to be done before the methods can be applied in practice.

ACKNOWLEDGEMENTS

This study has been carried out as a thesis work for the Master of Engineering degree at the Royal Institute of Technology in Stockholm.

The idea of this work was suggested by Captain Leif Ståhl, Crownair Ltd. Dr. Stefan Johansson at the Royal Institute of Technology in Stockholm has been my adviser and has developed suitable equipment for the experiments. I would like to express my gratitude to Dr. Johansson for his encouragement and support during this work. I also wish to thank Professor Klaus Biedermann at the Royal Institute of Technology for his valuable comments on the report.

I would also like to thank Mr. Lars-Olof Turesson, Chairman of the Bird Strike Committee of Europe, at the Board of Civil Aviation in Sweden, for useful discussions and helpful assistance with providing useful literature concerning the bird strike subject.

This project was partly financed by the Swedish insurance company Skandia.

REFERENCES

1. T. Alerstam, J.Karlsson, S. Ulfstrand: "Fåglar och flyg", Luftfartsverkets tryckeri, 1975.

2. P. Belton "Effects of Interrupted Light on Birds", Simon Fraser University, Burnaby, B.C.V5A 156, 1976.

3. G. Blom "Sannolikhetsteori och statistikteori med tillämpningar" Studentlitteratur, 1970.

4. Brehm-Ekman "Djurens liv IV, fåglar, andra delen", Sohlmans Förlag, Stockholm 1957.

5. J. Byström "Grundkurs i statistik", Natur och kultur, 1973.

6. J.D. Carhy "Djurens orienteringsförmåga", Wahlström & Widstrand, Stockholm 1964.

7. K. Fujimoto, T. Yanase, T. Hanaoka " Spectral Transmittance of Retinal Colored Oil Globules Re-examined with Microspectrophotometer" Jap. Jour. Physiol. 1957 7:339-346.

8. D.R. Griffin, R.P. Larkin, J. Torre-Bueno "Changes in Flight Patterns of Birds Induced by Searchlight Beams", in the report "A conference on the Biological Aspects of the Bird/Aircraft Collision Problem at Clemson University, distribured by NTIS, U.S. Department of Commerce, 1974, Page 422-427.

9. J.P.Hailman "Coding of the Color Preference of the Gull Chick" Nature London, vol 204 page 710, 1964.

10. J.P. Hailman "Mirror-Image Color-Preferences for Background and Stimulus-Object in the Gull Chick", Experimenta vol. 22, page 257-258, 1966.

11. B. Hanström " Djurens värld, band 8, fåglar I". Förlagshuset Norden AB, Malmö 1960.

12. H. Ikeda "The Spectral Sensitivity of the Pigeon", Vision Research, vol. 5, page 19-35, 1965.

13. M. Laty " Startling of Birds by Light: Experimental Measures; Current Research", in the report "11th meeting Bird Strike Committee Europe", BSCE/11 WP 11, Ministry of defence, Procurement Executive, London, U.K., 1976.

14. M. Laty "The Black-headed Gulls (Larus Ridibundus) are Assigned Their Quarters On Airfield", BSCE/10 1975, WP/13 (see ref . 24).

15. H. Laurens "Studies on the Relative Physiological Value of Spectral Light" The American Journal of Physiology, vol. 64, no 1, page 97-119, 1923.

16. P.E. Lindahl "Zoofysiologi, biologi 6", Almqvist & Wiksell 1967, Gebers Förlag AB.

17. S. Lustick "The effect of Intense Light on Bird Behavior and Physiology" in Proceedings, Sixth Bird Control Seminar 1973, Bowling Green State University, Bowling Green, Ohio 1973, page 171-186.

18. D.V. Norren "Two Short Wavelength Sensitive Cone Systems in Pigeon, Chicken and Daw", Vision Research, vol. 15, page 1164-1166, 1974.

19. P.V. Nye "An Examination of the Electroretinogram of the Pigeon in Response to Stimuli of Different Intensity and Wavelength and Following Intense Chromatic Adaption" Vision Research vol. 8, page 679-696, 1968.

20. Nyholm, Suneson, Österling "Gymnasiebiologi I", Esselte Studium AB, 1974.

21. M. Rudemo, L. Råde "Sannolikhetslära och statistik med tekniska tillämningar, del I", Biblioteksförlaget, 1970.

22. E.J. Ryback, W.B. Jackson, S.H. Vessey "Impact of Cooling Towers on Bird Migration", page 187-194, see reference 17.

23. E.J. Ryback, W.B. Jackson, S.H. Vessey Vertical Barriers to Migration" page 279-287, see reference 8.

24. H.H. Samson, M.L. Young "The Relation of Flash Intensity and Background illumination to the Photic Evoked Potential in the Pigeon's Optic Tectum", Vision Research, vol. 13, page 253-262, 1973.

25. A.S. Sillman "The Visual Pigments of Several Species of Birds", Vision Research, vol. 9, page 1063-1077, 1965.

26. J. Thorpe "Bird Strikes During 1973 to European Registered Civil aircraft", in the report "10th meeting, Bird Strike Committee Europe 1975", WP 5A, Luftfartsverkets Tryckeri 1975.

27. J. Thorpe "Bird Strikes During 1975 to European Registered Civil Aircraft", in the report "12th meeting Bird Strike Committee Europe", Appendix I, Inspection Générale de l'Aviation Civile, Paris, France.

28. J. Thorpe "Bird Strikes to Engines", WP/3, see reference 13.

29. N. Tinbergen "Gråtruten", Almqvist & Wiksell/Gebers Förlag, Stockholm, 1956.

CONCERNING LASERS:

30. "American National Standard for the Safe Use of Lasers", Published by the American National Standard Institute, New York, 1976 ANSI Z136.1, 1976.

31. Aviation Week & Space Technology, Sept. 4, 1978.

32. K. Biedermann "Strålningsfysik och Fotometri, Formelsamling" The Royal Institute of Technology, Stockholm, 1976.

33. Gunther Foit, 1971 Zapped in the macula by dual 30 mW focused argon laser beams; recovery complete.

34. G.R. Fowels "Introduction to Modern Optics" Second Edition, Holt, Rinehart and Winston,1975 (ISBN 0-03-089404-2).

35. Kungliga arbetarskyddsstyrelsens anvisningar nr 71, "Anvisningar angående skyddsåtgärder vid arbete med laser", Stockholm 1969.

36. Lappin, Lt. Col., et al, Arch. Ophthal. 84 (1970).

37. M. Minnaert "Nature of Light and Color in the Oper. Air", Dover, New Yor, 1954.

38. B. Tengroth "Laserns medicinska betydelse och dess skaderisker", Svenska Teknologföreningen 1971.

39. S. Thulin, A. Siklósi "Kompendium i laserfysik", The Royal Institute of Technology, Stockholm, tillämpad fysik , 1975.

BSCE 12
28 Octobre 1977

TABLE 1 COUNTRY -1975

Country	Number of Incidents (Aeroplanes)	Number of Movements (Aeroplanes only)	Rate per 10,000 Movements
Austria	2	44,500*	0.5
Belgium	53	127,172	4.2
Denmark	64	168,590	3.8
Eire	16	70,120*	2.3
Finland	0	73,720	0
France	80	566,370	1.4
Italy+	12	108,790*	1.1
Netherlands	202	197,370	10.2
Norway	26	202,670	1.3
Sweden	54	193,520*	2.8
Switzerland	72	181,316	4.0
UK	357	1,003,604	3.6
TOTAL	938	2,940,000	3.2

Notes: 1.1 There are two movements per flight.

*1.2 Movement data for Austria, Eire, Italy and Sweden is approximate (based on ICAO sources).

+1.3 Data from Italy is for second half of year.

1.4 Data from Switzerland is for Swissair only.

1.5 Data from France and Norway does not include piston-engined aircraft.

1.6 Helicopters are excluded from this table.

1.7 Very limited data from Germany is used in Table 6.

TABLE 8 **COST - 1975** Belgium, Denmark, France, Netherlands Switzerland and U.K. only.

Type	Aircraft Movements	Damaging Strikes	Cost
Where cost is known	1,291,468	95	$107,1380
Where cost is unknown	1,646,274	-	
LIKELY TOTAL COST	2,937,742		$2.44 million

Notes: 8.1 The cost from those countries able to supply cost information has been factored by the TOTAL of aircraft movements for all the countries covered by this Analysis.

CONFIDENCE INTERVAL AND GOODNESS OF FIT

STATISTICAL THEORY, some statements [3]

The arithmetic mean $\bar{x} = \frac{1}{n}\sum_{j=1}^{n} x_j$

The standard deviation $s = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(x_j-\bar{x})^2}$

1) If $x_i \varepsilon N(m,\sigma)$ and x_i independent, then

$$\frac{1}{\sigma^2}\sum_{i=1}^{n}(x_i-\bar{x})^2 \varepsilon \chi^2(n-1)$$

2) X is χ^2 distributed if the density function of x is of the form

$$k\cdot x^{\frac{f}{2}-1}\cdot e^{-\frac{x}{2}} \qquad x>0$$

3) If $x\varepsilon N(0,1)$ and $y\varepsilon\chi^2(f)$, x and y independent, then

$$z = \frac{x}{\sqrt{\frac{y}{f}}}$$

is t-distributed with f number of degrees of freedom.

4) X is t-distributed if the density function of x is

$$k\cdot(1+\frac{x}{f})^{-\frac{(f+1)}{2}} \qquad -\infty < x < \infty$$

with f number of degrees of freedom.

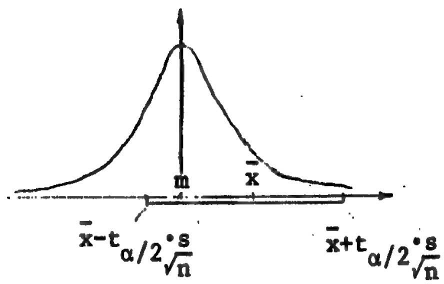
5) If $y = \frac{\bar{x}-m}{\sigma}$ and $x\varepsilon N(m,\sigma)$ then $Y\varepsilon N(0,1)$ if σ is known.

6) When σ is unknown, $\frac{\bar{x}-m}{\frac{s}{\sqrt{n}}}$ is t-distributed with n-1 number of

degrees of freedom.

CONFIDENCE INTERVAL

A confidence interval at a level $1-\alpha$ tells that with a probability of $1-\alpha$ the correct value (here of the mean) lies within the interval.



Formula:

$$I_m = (\bar{x} - t_{\alpha/2}(n-1)\cdot\frac{s}{\sqrt{n}}\ ,\ \bar{x} + t_{\alpha/2}(n-1)\cdot\frac{s}{\sqrt{n}}\ )$$

Here $t_{\alpha/2}$ is used, as σ is unknown and estimated at s .

NULL HYPOTHESIS BY CONFIDENCE INTERVAL

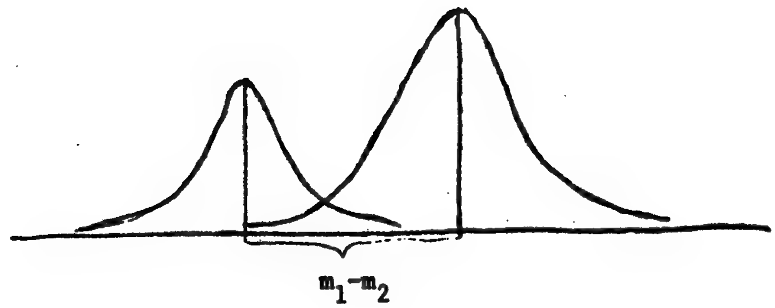
To test if the results obtained varied more than randomly from the figures achieved in the reference test, confidence intervals for the difference in distributions between the experiments were carried out.

Due to the fact that σ is unknown, the t-distribution must be used. As the number of degrees of freedom, f, vary among the investigations, a common factor f_c must be calculated. This is performed with the Welch and Aspin formula [21]:

$$\frac{1}{f_c} = \frac{1}{n_1-1}\cdot\left(\frac{n_2 s_1^2}{n_1 s_2^2 + n_2 s_1^2}\right)^2 + \frac{1}{n_2-1}\cdot\left(\frac{n_1 s_2^2}{n_1 s_2^2 + n_2 s_1^2}\right)^2$$

Then the confidence interval for the difference in distribution between the reference and the other experiment becomes:

$$I_{m_1-m_2} = (\bar{x}_1 - \bar{x}_2 - t_{\alpha/2}\cdot\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\ ,\ \bar{x}_1 - \bar{x}_2 + t_{\alpha/2}\cdot\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\ )$$



If there is any difference between the results with the paper wings and the reference, or between sweeping light and the reference which could not be explained by chance (that is, the null hypothesis is false), then null should not be included in the confidence interval. If the interval does not include null, then the difference between the results is said to be statistically significant.

GOODNESS OF FIT

To examine if the observed frequencies of the results in the laser experiment differed more than randomly from the expected distribution (that is, the one achieved if only chance influenced the results) the chi-square test was applied to the results [5]:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where O_i is observed frequency and E_i the expected one.

APPLICATION *of the theory to* THE EXPERIMENTS *with the* PAPER WINGS *and the* LIGHT

At first it was analysed if the results obtained in the experiments were distributed according to any special function. An assumption that the results were distributed according to the normal function, was tested by comparing the figures to the proper normal function. It was found that the figures held to be approximately normal-distributed(Gauss).

Then the parameters of the normal distribution, N(m,σ) were estimated at the arithmetical mean, $\bar{x} \sim m$, and the standard deviation, $\sigma \sim s$. For the results from the experiments with the paperwings of different colours and the symbolic light, the confidence intervals were estimated at 90% and 95% levels for each colour. The null hypothesis (the hypothesis that the results obtained did not vary more than randomly from the reference results) was tested at the same level for each set of data.

The results from the laser experiment were examined by applying a chi-square test to the data, in order to test the goodness of fit.

RESULTS OBTAINED WITH THE PAPER WINGS

The figures in the table represent the distance at which all gulls flew off the ground, where they were sitting eating. The results are arranged according to magnitude – the shortest distance first – and are given in metres.

	BLUE	GREEN	YELLOW	RED	WHITE	REFERENCE
	51	49	7-	15-	35-	30
	53	50	27'	45	47	30
	53	50	30'	50	50	30
	53	53	30'	50	50	33
	55	55	45	53	51	35
	60	55	45	53	53	35
	60	55	45	58	55	37
	60	55	47	60	55	37
	63	55	48	60	57	40
	75	58	50	70	60	40
		75-	50	75	60	40
		100-	51		65	40
		150-	51		70	40
			53			41
			53			47
			55			47
			55			53
			57			53
						55
						60
n	10	10	17 (14)	10	12	20
$\bar{m}$	58.3	53.5	46.6 (50.4)	57.4	56.1	41.2
s	7.1	2.9	9.1 (4.0)	9.3	6.7	8.7
Md	57.5	55	50 (50.5)	55.5	55	40

n: number of experiments

$\bar{m}$: arithmetic mean

s: standard deviation

Md: median

The dash marked figures are, due to their being extreme values, excluded in the calculations. The marked figures in the "yellow" column are excluded for the figures between brackets.

RESULTS OBTAINED WITH LIGHT

	WHITE, lit	WHITE, ref	BLUE, lit	BLUE, ref	WHITE, on car	REFERENCE
	0-	25	16	44	0	30
	30	27	17	44	0	30
	31	30	22	45	0	30
	32	33	26	45	3	33
	32	33	28	47	7	35
	35	35	30	47	7	35
	50	35	35	48	10	37
	55	35	38	48	13	37
	55	37	39	48	15	40
	75	40	40	49		40
	75	45	43	50		40
	75	47	45	51		40
		51	45	55		40
		60	47			41
		60	60-			47
		65				47
		65				53
		70				53
						55
						60
n	11	18	14	13	9	20
$\bar{m}$	49.5	44.1	33.6	47.8	6.1	41.2
s	18.9	14.4	10.5	3.1	5.8	8.7
Md	50	38.5	36.5	48	7	40

WHITE,lit means trials with the ramp, where the lamps have been set to twinkle by pairs, so that a sweeping light propagation is achieved.

WHITE, reference stands for experiments with the ramp unlighted.

REFERENCE here is identical to the column on page 5, and is repeated here only for comparison.

The colour blue was achieved by covering the ramp with blue plastic; therefore the reference, blue, means the experiments with the covered, unlit ramp which made a blue impression.

CONFIDENCE INTERVALS for the experiments with the paper wings and the symbolic light

a) paper wings

formula:

$$I_m = (\bar{x}-t_{\alpha/2}\cdot\frac{s}{\sqrt{n}}\ ,\ \bar{x}+t_{\alpha/2}\cdot\frac{s}{\sqrt{n}}) \qquad \alpha=10\%$$

blue	(54,62)	
green	(52,55)	
yellow	(43,50)	(49,52)
red	(52,63)	
white	(53,60)	
reference	(38,45)	

b) symbolic light

white, lit	(39,60)
white, reference	(38,50)
blue, lit	(29,39)
blue, reference	(46,49)
white, on car	(3,10)
reference (same as above)	(38,45)

The confidence interval I_m tells that with a probability of 90% the correct value of the mean of the scaring distance (in meter) lies within the interval (see appendix II, p 2). As an example, (54,62) means the interval 54 metres to 62.

CONFIDENCE INTERVALS for the difference in distribution - significant results

	set of results compared	f	$t_{\alpha/2}, \alpha=5\%$	$t_{\alpha/2}, \alpha=10\%$	$I_m, \alpha=5\%$	$I_m, \alpha=10\%$
paper wings:	blue - ref	22	2.07	1.72	(11,23)	(12,22)
	green-ref	26	2.06	1.71	(8,17)	(9,16)
	yellow-ref, a	33	2.04	1.70	<u>(-1,11)</u>	<u>(0,10)</u>
	yellow-ref, b	28	2.05	1.70	(5,14)	(5,13)
	red-ref	18	2.10	1.73	(9,24)	(10,22)
	white-ref	28	2.05	1.70	(9,21)	(10,20)
light:	white-ref	12	2.18	1.78	<u>(-5,21)</u>	<u>(-2,19)</u>
	white,unlit-ref	27	2.05	1.70	<u>(-5,11)</u>	<u>(-4,10)</u>
	blue-ref	25	2.06	1.71	(-15,-1)	(-13,-2)
	blue,unlit-ref	26	2.06	1.71	(2,11)	(3,10)
	white,car-ref	23	2.07	1.71	(-41,-30)	(-40,-30)
references, light:	white,lit-white,unlit	17	2.11	1.74	<u>(-9,19)</u>	<u>(-6,17)</u>
	blue,lit-blue,unlit	15	2.13	1.75	(-20,-8)	(-19,-9)
ramp ref:	white,unlit-blue,unlit	19	2.09	1.73	<u>(-11,4)</u>	<u>(-10,2)</u>

The underlined figures mean that the difference in distribution between the results is not significant.

f = number of degrees of freedom. For I_m and $t_{\alpha/2}$ see appendix II, page 2.

AD F 616 094

WP 18

EVALUATING THE BIRDSTRIKE THREAT TO AIRCRAFT WINDSHIELD SYSTEMS - A PROBABILISTIC APPROACH[1]

Ralph Speelman
USAF
Flight Dynamics Laboratory
Wright-Patterson AFB, Ohio, USA

Figure 1 - The purpose of this report is to briefly describe and illustrate a recent effort to analyze the potential risk of birdstrike damage to an aircraft windshield system.

Figure 2 - This development affords us another weapon for use in our bird war battles. The technique results in predicting the probability of birdstrike damage thru statistical consideration of 4 factors: Number of impacts, bird weight, impact velocity, and impact component strength.

Figure 3 - The approach which will be taken in describing this technique is to briefly describe the statistical model formulation, describe the components of the model, apply the technique and summarize the findings to date.

Figure 4 - The technique was formulated by Dr. John Halpin, USAF, during his efforts to assess the adequacy of windshield system birdstrike protection being designed into a new aircraft. Subsequent model development, analysis and documentation were performed by the University of Dayton Research Institute (UDRI). The effort at UDRI was sponsored by the Air Force Flight Dynamics Laboratory. Principal investigators at UDRI were: A. Berens, B. West, and M. Turella.

Figure 5 - Regardless of preventive measures, birdstrikes will occur. USAF experience is that there are about 35 birdstrikes per 100,000 flight hours. It is obviously unrealistic to protect against all levels of potential birdstrikes, so the general approach, as you all well know, is to pick a protection level which is felt to reasonably represent the risk to be encountered. However, once this desired protection level is established, we must consider two questions: "What happens if I hit a bigger bird at a slower speed or a smaller bird at a higher speed?" and, "How likely is such an occurrence?" The answers to these two questions are, of course, a function of such things as geographical location, aircraft altitude, aircraft mission, and aircraft design. An ability to analytically assess this risk to a transparency system, from birdstrike hazards other than those for which it was designed, is truly needed. It is this need which prompted the work being reported on today.

Figure 6 - What are the factors which influence whether a birdstrike will result in damage to the windshield system? Intuitively, the probability of damage due to a single birdstrike is a function of the bird weight, the

[1]Oral presentation outline for use at the Birdstrike Committee Europe Meeting in The Hague, Netherlands during 22-26 October 1979.

impact velocity, and the strength of the impact point. Carrying this intuition one step further, the probability of birdstrike damage during a flight is then the probability of damage due to a single birdstrike times the expected number of birdstrikes. It was hypothesized that if each of these factors could be identified in a statistical fashion, there should be some manner of mathematically combining them.

Figure 7 - The model formulated by Dr. Halpin was based on the premise that the expected number of birdstrikes can be predicted and that damage will result when the kinetic energy from a birdstrike is greater than some critical level. It was assumed that a velocity distribution for the aircraft and weight distribution for the birds could be combined to predict a probability distribution for kinetic energy. By assuming that the ability of any given windshield system to defeat a birdstrike is essentially related to impact kinetic energy and impact location, we can identify the proportion of the windshield system which will be damaged as a function of birdstrike kinetic energy level. Mathematically combining the kinetic energy probability distribution with the critical strength level distribution will produce the probability of damage due to a single birdstrike. Combining the expected number with the probability of damage yields the expected number of damaging birdstrikes.

Figure 8 - Let's take a brief examination of how these terms can be quantified. The first one is the expected number of strikes. The equation is not new to those of you who have worked with this problem. D represents the birds per unit volume through which the aircraft is flying and $A\bar{V}T$ represents the volume swept by the component of concern. It is important to note that in computing the values for these terms, there is a necessity to give serious attention to the environment of concern. It must be relevant to the specific problem being addressed and must be common for each of the terms. The expected number of damaging birdstrikes, as opposed to the expected number of strikes, is then the expected number of strikes times the probability that any one strike will result in damage. The probability of a birdstrike causing damage is obtained by an integration which considers the probability that a specific kinetic energy will occur, and the probability that damage will occur at that kinetic energy.

Figure 9 - It is this computation of the probability of damage which represents Dr. Halpin's major contribution. Mathematically, this term relates the probability that a specific KE will occur and the probability that damage will result at this KE. It combines the bird weight distribution, $f(w)$, the impact velocity distribution, $f(v)$, and determines the probability that the resulting kinetic energy will exceed the critical value necessary to result in damage.

Figure 10 - Let's now take a look at how this technique was applied to a situation which would seem representative of the necessity to assess the risk of birdstrike damage. We have an existing aircraft where mission profiles are being revised to improve low-altitude proficiency. Those responsible for flight safety were concerned with the increase in birdstrike risk due to the increased low-altitude flying time. Information was needed which they could use in considering both the effects of additional flight time in the birdstrike environment and the effects of improving

windshield system birdstrike resistance. In short, what is the birdstrike risk to the crew and the aircraft due to increased low-altitude flight time, and what modifications of the windshield system would be required to reduce this risk.

Figure 11 - We know that there are four factors required to use the probablistic approach: the expected number of birdstrikes, the bird weight distribution, the velocity of impact distribution and the windshield system strength distribution. Let's take a brief look at how values were computed for these four parameters.

Figure 12 - Factor 1, Expected Number of Birdstrikes. Birdstrike records for this specific aircraft were on hand so these were used along with operational records of velocity by altitude band to establish the expected number of birdstrikes per 100,000 flight hours. The equation was left in terms of average velocity and percentage of flight time below 5,000 feet so that it could be used to consider the effects of increased low-altitude missions.

Figure 13 - Factor 2, Bird Weight Distribution. Birdstrike records for this specific aircraft were again used in establishing the bird weight distribution characteristics. The records show a specific quantity of birdstrikes occurring over a period of time. A certain percentage of this quantity was identifiable as to type of bird. This ratio of identifiable types was then assumed to exist for the entire quantity. Bird weight reference data was used to establish the weight distribution. The resulting cumulative distribution curve for this bird weight is as shown in the figure.

Figure 14 - Factor 3, Velocity Distribution. Operational records for this specific aircraft were used to establish the representative cumulative velocity distribution profile shown in the figure. The equation for the curve allows consideration of the effects on the overall distribution through increasing the quantity of low-altitude flights.

Figure 15 - Factor 4, Strength Distribution. Based on prior birdstrike testing of this aircraft windshield system, a strength distribution profile was computed by assuming that failures were representative of failure at a kinetic energy level. Based on current windshield system state-of-the-art, including operational considerations such as cost, weight, and visibility, a series of possible design modifications were established. Strength distribution profiles for these system modifications were estimated as shown. Now that all four factors are mathematically defined, let's see what the technique predicted.

Figure 16 - Predicted windshield system birdstrike penetrations for a ten-year period are shown. Note that there are four different versions of missions; the existing mission, and the existing mission with multiple increments of low-altitude flights. Note also that there are 4 different versions of the windshield system; the existing system and then 3 modifications of that existing system. Since I haven't presented you with the exact numbers which were used in applying the technique the specific numbers have little meaning to you other than that they show trends and the significant

improvements attainable through any one of the system modifications. Design options which will allow implementation of any one of the modifications are currently being pursued. Final selection will be made by about mid-1980.

Figure 17 - But how realistic are these predictions? A prediction technique such as this produces results which are only as realistic as are the inputs. Examining model sensitivity to inputs revealed that results can vary quite significantly. The approach used to get a measure of how realistic were the predictions, was to take a backward glance at how well this model would have predicted losses over a ten-year period ending with the current period. These loss predictions could then be compared with the actual losses and hopefully the results would indicate some degree of realism between model and actual results. Flight records for the ten-year period for this specific aircraft revealed that the canopy experienced 17 birdstrikes with roughly 6-8 of these being recorded as "failures." The windshield experienced 29 birdstrikes with roughly 1-2 of these being recorded as "failures." The "failures" were representative of penetration or significant fracture and partial loss of a portion of the canopy. Resulting probabilities of failure were as shown on the figure. Applying the probabilistic technique for the same time period resulted in a predicted probability of failure as shown. The correlation between the actual and the predicted was rather reassuring.

Figure 18 - We have a risk assessment technique which is available for use in the continuing bird war battle. The technique is sensitive to bird density, bird weight, impact velocity, and impact area strength distributions. This sensitivity has both negative and positive implications. On the negative side it permits either accidental or intentional bias to distort the results. On the positive side it permits consideration of specific alterations to the input data and thus, allows recognition of the overall problem complexity. The ability to derive the prerequisite distributions from operational data improves confidence in the resulting risk assessment as these distributions, if selected with care, can truly represent the specific operational environment of concern. Applications where all four distributions must be hypothesized, such as for a new aircraft in a new role, thus involve the highest risk of improper interpretation of results. Applications involving lower risk in interpreting the results are those where fewer distributions must be hypothesized, as opposed to derived from operational data. For example, changing operating locations with a given aircraft and mission profile or changing mission profile without changing aircraft or operating location. Investigations have shown that the sensitivity of the technique can be reduced, if desired, through future model developments. Until such development is accomplished, however, it is felt that the technique does have current application providing realistic distributions for the four factors are established representing a common operational environment of concern.

BACKUP FIGURES

A. Characteristic distribution shapes. Weight and velocity distribution are of the Weibull type; strength distribution is of linear segments.

B. Computation of probability density function of impacting kinetic energies.

EVALUATING THE BIRDSTRIKE
THREAT TO AIRCRAFT CREW
ENCLOSURES - A PROBABILISTIC APPROACH

PRESENTED BY:
RALPH SPEELMAN
USAF FLIGHT DYNAMICS
LABORATORY

FIGURE 1

BIRD WAR

OUTLINE

- PROBLEM = NEED
- STATISTICAL MODEL FORMULATION
- MODEL COMPONENTS
- MODEL APPLICATION
- SUMMARY

FIGURE 3

ACKNOWLEDGEMENT

BASED ON AN INITIAL MODEL FORMULATED BY DR. J. HALPIN, USAF, W-PAFB, OHIO. SUBSEQUENT MODEL DEVELOPMENT, ANALYSIS AND DOCUMENTATION PERFORMED BY UNIVERSITY OF DAYTON RESEARCH INSTITUTE (UDRI), DAYTON, OHIO. UDRI EFFORT SPONSORED BY USAF FLIGHT DYNAMICS LABORATORY, W-PAFB, OHIO.

UDRI PRINCIPAL INVESTIGATORS:

A. BERENS
B. WEST
M. TURELLA

FIGURE 4

BIRDSTRIKES -

-DO OCCUR

- PROTECTION LEVEL CAN
BE SPECIFIED AND VERIFIED

- NEED RISK ASSESSMENT CAPABILITY

FIGURE 5

FACTORS OF INFLUENCE
-INTUITIVE-

- PROBABILITY OF BIRDSTRIKE DAMAGE DUE TO A SINGLE BIRDSTRIKE = P(D)
  - BIRD WEIGHT
  - IMPACT VELOCITY
  - STRENGTH OF IMPACT POINT
- PROBABILITY OF BIRDSTRIKE DAMAGE DURING A FLIGHT
  - P(D) × (EXPECTED NUMBER OF STRIKES)

FIGURE 6

STATISTICAL MODEL FORMULATION

ASSUMPTIONS

- EXPECTED NUMBER OF BIRDSTRIKES CAN BE PREDICTED
- DAMAGE WILL RESULT WHEN :

  KINETIC ENERGY ≥ CRITICAL LEVEL

  - KE IS PREDICTABLE:
    - VELOCITY DISTRIBUTION
    - BIRD WEIGHT DISTRIBUTION
  - CL IS PREDICTABLE:
    - AREA OF "DAMAGE" KNOWN AS FUNCTION OF KE

FIGURE 7

EXPECTED NUMBER OF STRIKES:

$E_{(n)} = D\,A\,\overline{V}\,T$

D = OPERATIONAL BIRD DENSITY WITHIN ENVIRONMENT OF CONCERN

A = FRONTAL AREA OF CONCERN

$\overline{V}$ = AVERAGE VELOCITY WITHIN ENVIRONMENT OF CONCERN

T = TIME WITHIN ENVIRONMENT OF CONCERN

EXPECTED NUMBER OF DAMAGING BIRDSTRIKE:

$E_{(N)} = E_{(n)}\,P(D)$

$P(D)$ = PROBABILITY OF A BIRDSTRIKE CAUSING DAMAGE

FIGURE 8

PROBABILITY OF A BIRDSTRIKE CAUSING DAMAGE

$$P(D) = \int_0^\infty P(KE)\, P\,(D/KE)\, dKE$$

P(KE) = PROBABILITY DENSITY FUNCTION OF IMPACTING KINETIC ENERGIES. CALCULATED FROM f(W), BIRDWEIGHT DISTR, AND f(V), VELOCITY DISTR.

P(D/KE) = PROBABILITY OF DAMAGE AT AN IMPACT KE LEVEL.

FIGURE 9

APPLICATION

SITUATION

- EXISTING AIRCRAFT
- LOW ALTITUDE MISSION QUANTITY BEING INCREASED
- NEED BIRDSTRIKE HAZARD ASSESSMENT AS FUNCTION OF
  - LOW ALTITUDE MISSION QUANTITY
  - WINDSHIELD SYSTEM BIRDSTRIKE PROTECTION LEVEL

FIGURE 10

INFORMATION REQUIRED TO USE THE PROBABILISTIC APPROACH

1. EXPECTED NUMBER OF BIRDSTRIKES

2. BIRDWEIGHT DISTRIBUTION

3. VELOCITY DISTRIBUTION

4. WINDSHIELD SYSTEM STRENGTH DISTRIBUTION

FIGURE 11

1. EXPECTED NUMBER OF BIRDSTRIKES

$$E(n) = DA\bar{V}T$$

— BIRDSTRIKE RECORDS FOR SPECIFIC AIRCRAFT

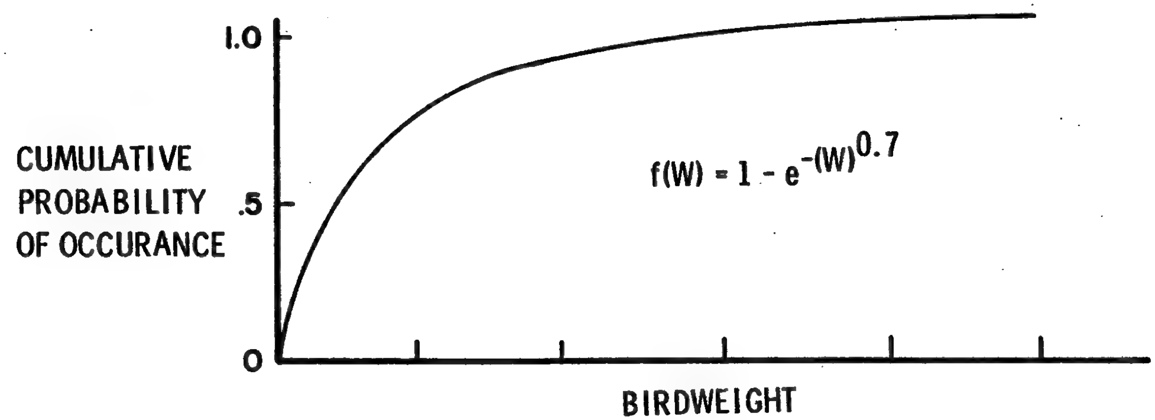
— OPERATIONAL RECORDS OF VELOCITY BY ALTITUDE BAND

$$\frac{E_{(n)}}{100,000 \text{ flight hours}} = \left[\bar{V}\,(.012)\right]\left[\%T \text{ at ALT.} < 5,000 \text{ ft.}\right]$$

FIGURE 12

2. BIRDWEIGHT DISTRIBUTION

- BIRDSTRIKE RECORDS FOR SPECIFIC AIRCRAFT
- BIRDWEIGHT CHARACTERISTICS REFERENCE DATA *

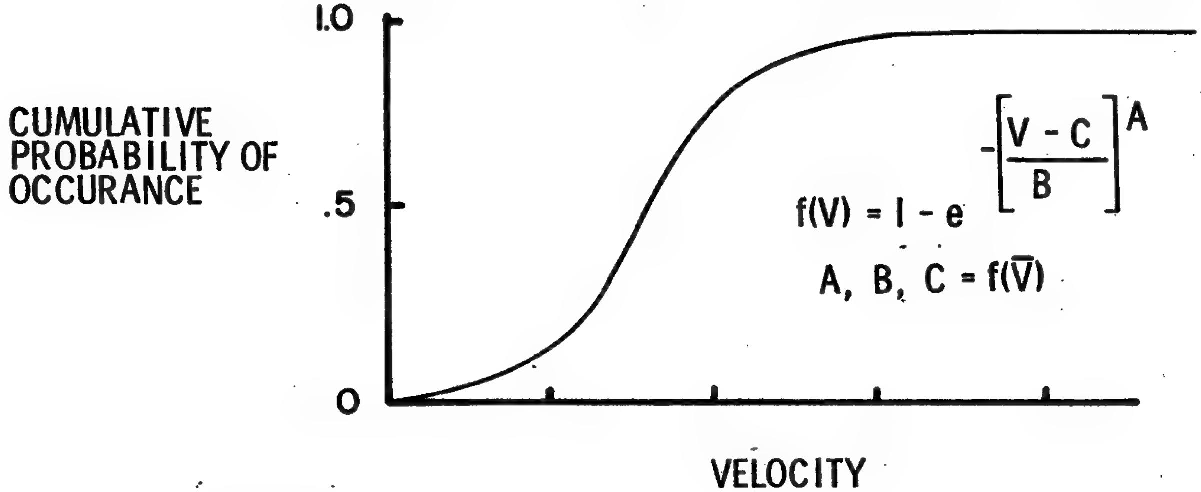


* AFFDL-TR-73-103 'WINDSHIELD BIRD STRIKE STRUCTURE DESIGN CRITERIA' J. H. LAWRENCE AND M. J. COKER

FIGURE 13

3. VELOCITY DISTRIBUTION

- OPERATIONAL RECORDS
- ADDITIONAL LOW ALTITUDE MISSIONS



$$f(V) = 1 - e^{-\left[\frac{V - C}{B}\right]^{A}}$$

$$A,\ B,\ C = f(\overline{V})$$

FIGURE 14

4. STRENGTH DISTRIBUTION

- PRIOR BIRDSTRIKE TEST RESULTS
- BIRDSTRIKE RESISTANCE STATE OF THE ART
- OPERATIONAL CONSIDERATIONS, COST, WEIGHT, VISIBILITY, ETC.

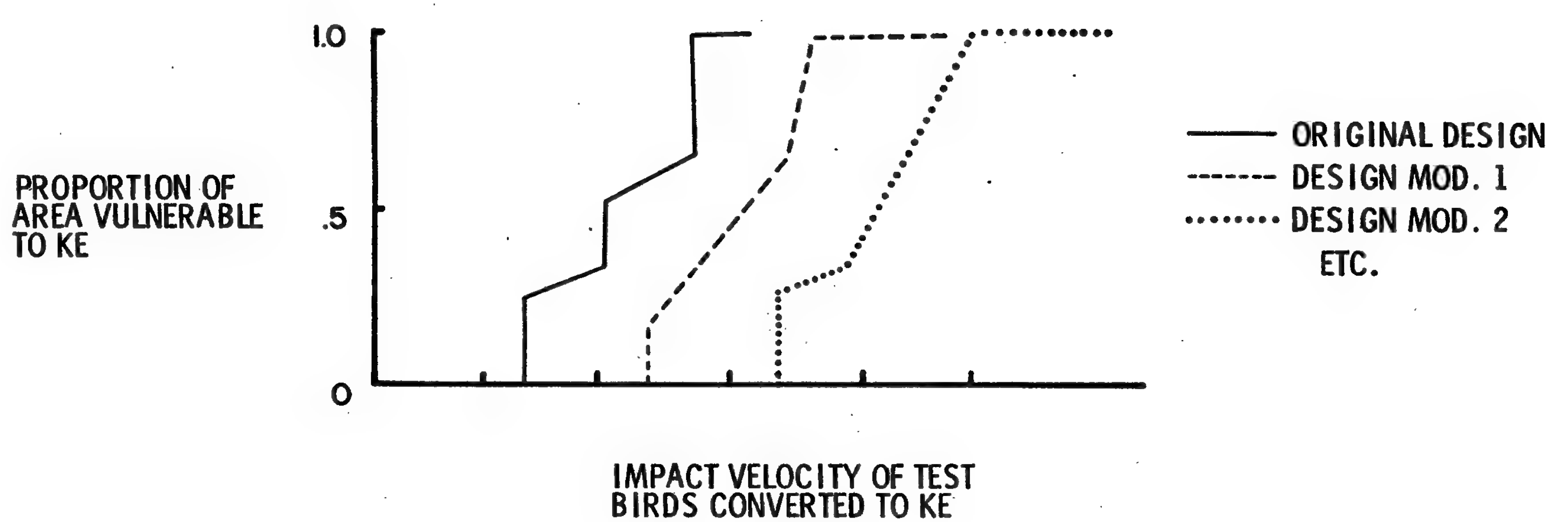


FIGURE 15

RESULTS
PREDICTED PENETRATIONS
(10 YEAR PERIOD)

MISSIONS	WINDSHIELD SYSTEM			
	EXISTING	MOD. 1	MOD. 2	MOD. 3
EXISTING	7.1	0.9	0.6	0.4
EXISTING WITH X LOW ALTITUDE FLIGHTS	8.3	1.3	0.9	0.7
EXISTING WITH 2X LOW ALTITUDE FLIGHTS	9.6	1.7	1.2	1.0
EXISTING WITH 3X LOW ALTITUDE FLIGHTS	11.3	2.3	1.7	1.4

FIGURE 16

MODEL ASSESSMENT

FLIGHT RECORDS (1968-1978)	CANOPY	WINDSHIELD
BIRDSTRIKES RECORDED	17	29
SYSTEM 'FAILURES'	6-8	1-2
ACTUAL PROBABILITY OF FAILURE	.35-.47	.035-.068
USE OF PROBABILISTIC MODEL		
PREDICTED PROBABILITY OF FAILURE	.31	.047

FIGURE 17

SUMMARY

- RISK ASSESSMENT TECHNIQUE AVAILABLE
- TECHNIQUE SENSITIVE TO:
  - BIRD DENSITY DISTRIBUTION
  - BIRD WEIGHT DISTRIBUTION
  - IMPACT VELOCITY DISTRIBUTION
  - IMPACT AREA STRENGTH DISTRIBUTION
- DEGREE OF SENSITIVITY REFLECTS PROBLEM COMPLEXITY:
  - NEW AIRCRAFT
  - AIRCRAFT OPERATING LOCATION CHANGE
  - AIRCRAFT MISSION CHANGE
  - HARDWARE MODIFICATION
- DEGREE OF SENSITIVITY CAN BE REDUCED

FIGURE 18

DISTRIBUTION FUNCTIONS

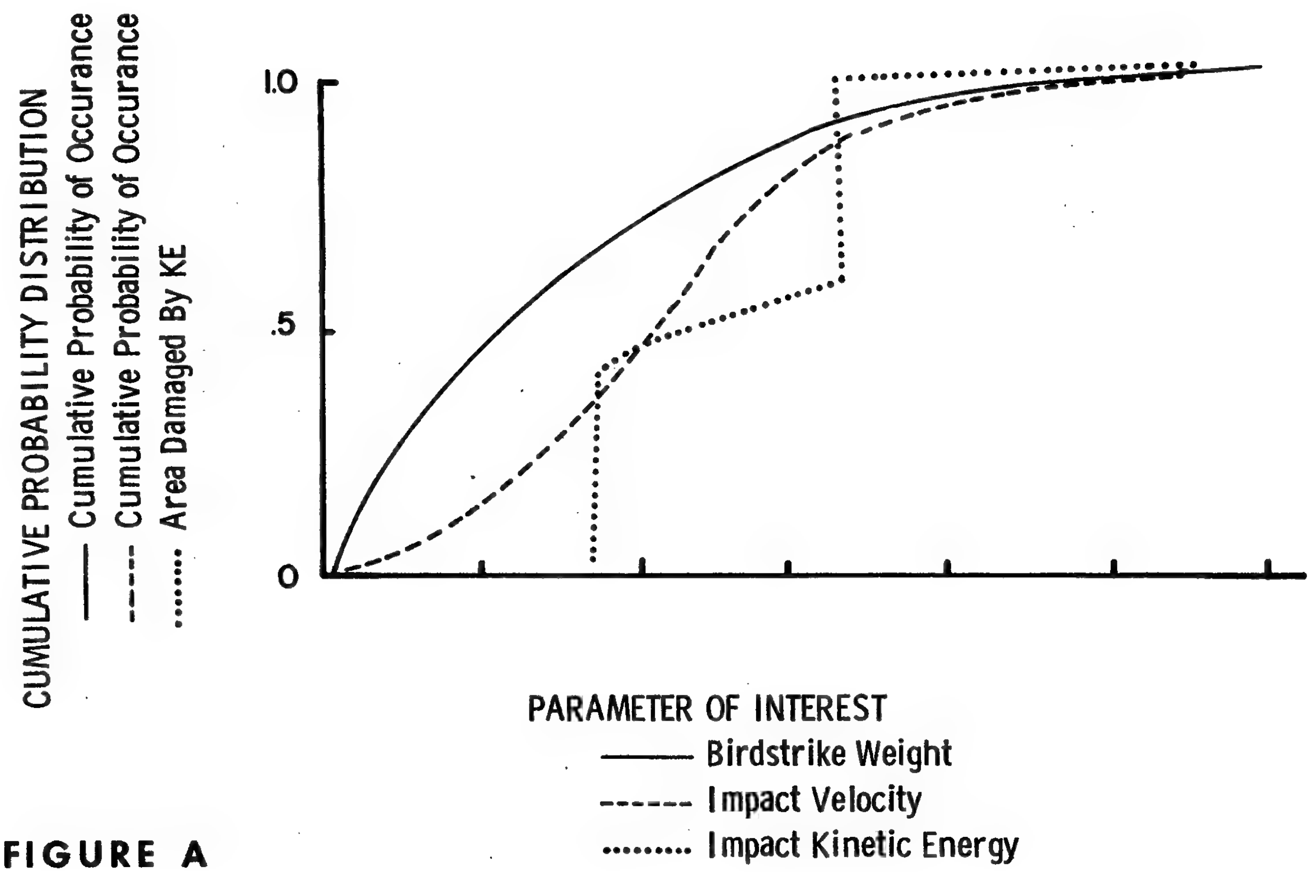


FIGURE A

P(KE) = PROBABILITY DENSITY FUNCTION OF IMPACTING KINETIC ENERGIES

C(KE) = CUMULATIVE DISTRIBUTION OF KE

$$C(KE) = P(KE \leq KE^*)$$

$$= P\left[\frac{WV^2}{2g} \leq KE^*\right]$$

$$= \int_0^\infty \left[\int^{\frac{2gKE^*}{V^2}} f(W)\, dW\right] f(V)\, dV$$

$$P(KE) = \frac{d\, C(KE)}{d\,(KE)}$$

$$= 2g \int_0^\infty \frac{1}{V^2}\, f\left[\frac{2g\, KE^*}{V^2}\right] f(V)\, dV$$

FIGURE B

AD F616 097

BSCE 14 / WP 19

The quality of identification: a microscopic key to the determination of feather-remains.

T. G. Brom & L. S. Buurma

The statistics of bird collisions are distorted by an enormous bias (see lecture Buurma/Brom, WP 20):

1. Outsiders (non-ornithologists) can recognize only a few species of birds.
2. The chance that remains of conspicuous birds are found is much greater than for those of smaller birds.
3. Remains of collisions on airfields are much more frequently found than those of collisions "en route".

As it is very important to find out which species cause which damages, the Royal Netherlands Air Force attaches great importance to the correct identification of bird remains that are collected after collisions. In order to improve existing methods of identification, a study was made from January 1978 until August 1979.

During the last twenty years it was tried to identify feather-remains at the Zoological Museum, Amsterdam. They were examined on shape and structure in order to establish whether they are wing-, tail-, or body-feathers. On account of the colour and size the potential species were established. Then the feathers were compared with bird-skins from the collection of the Museum.

Skins of Redwings (Turdus iliacus) and Song Thrushes (T. philomelos) at the Zoological Museum, Amsterdam.

The results of this macroscopic identification are given in table I.

Table I Some identification-results in the sixties.

	I960		I966-68	
species	9	I3%	45	I6%
probable species	4	6%	-	-
family	20	28%	63	22%
probable family	4	6%	-	-
unknown	34	48%	I74	62%

In order to reduce the high percentage "unknown", a microscopic study of feathers from 350 bird-species was made. The technique of making preparations of feathers or feather portions is simple and does not take much time: the feather portions are mounted dry under a coverslip. Only the most basal portion of a feather is taken (see figure I and 2).

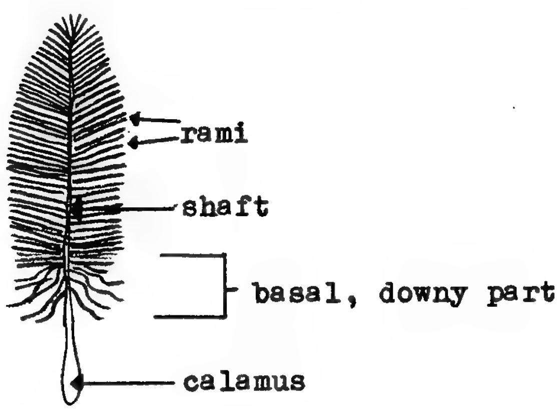


Figure I

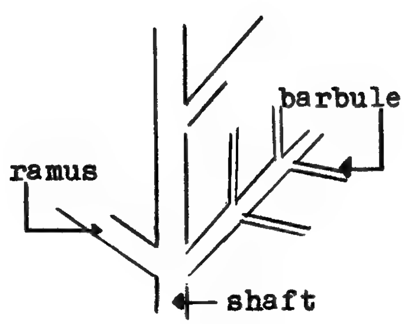


Figure 2

At the barbules (see figure 2), the characters on which groups (or species) of birds can be separated are to be found; to mention some:

- presence of prongs at the barbules (figure 3)
- barbules whether or not distinctly subdivided into nodes and internodes (figure 4)
- distribution and shape of the nodes (figure 5)
- presence of multiple nodes (figure 6)
- presence of villi (outgrowths) at the bases of the barbules (figure 7)
- lenght of the barbules
- number of nodes per mm. barbule

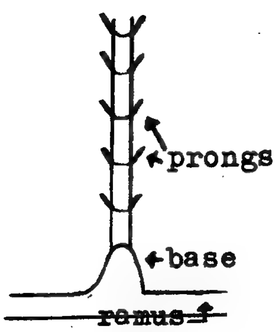


Figure 3

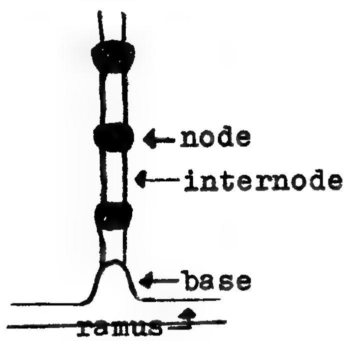


Figure 4

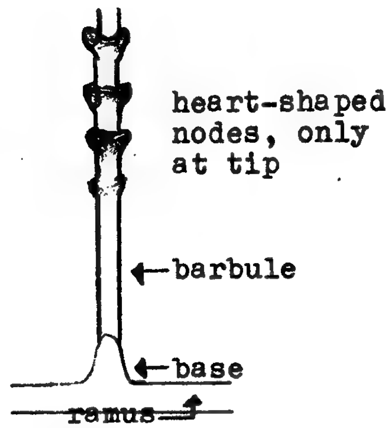


Figure 5

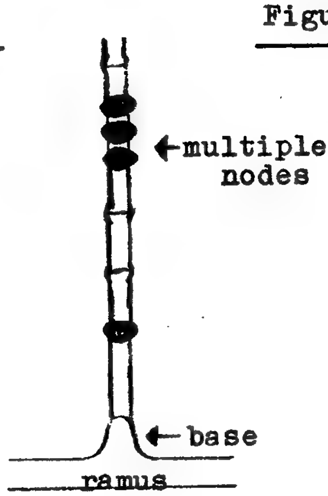


Figure 6

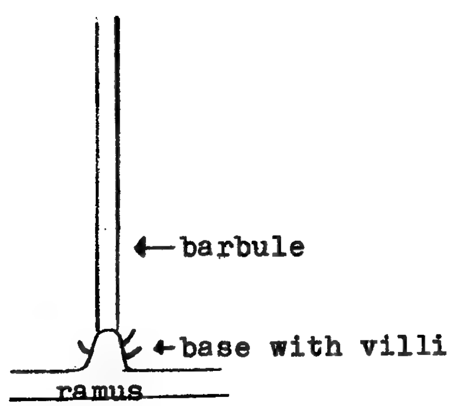
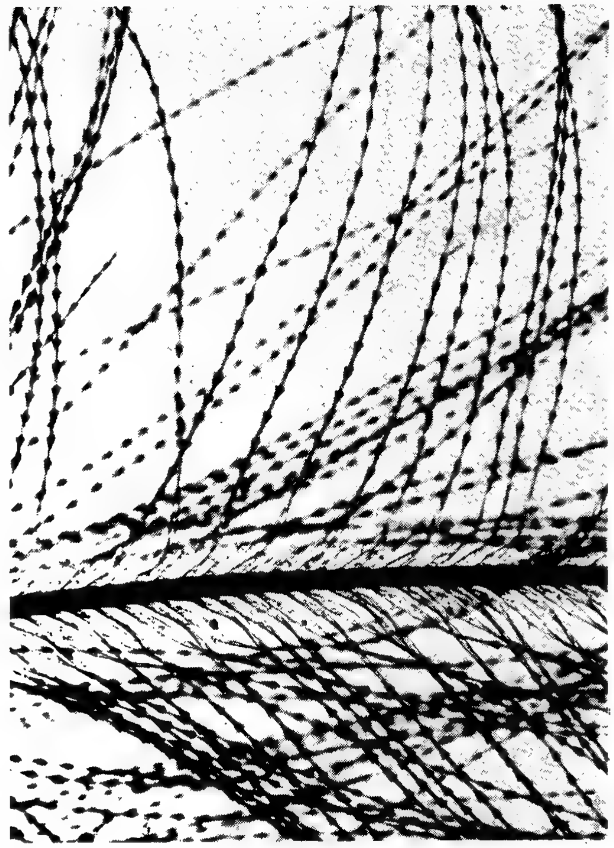


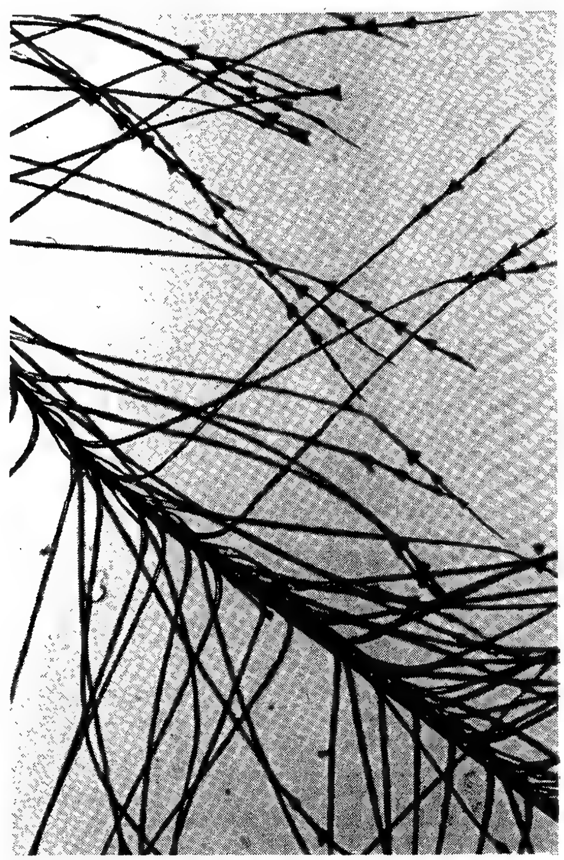
Figure 7

Barbules with prongs; Gannet Sula bassana (165x)



Subdivision into pigmentated nodes and internodes; Lesser Spotted Woodpecker Dendrocopus minor (130x)

Villum at the base of a barbule; Hooded Crow Corvus corone cornix (510x)

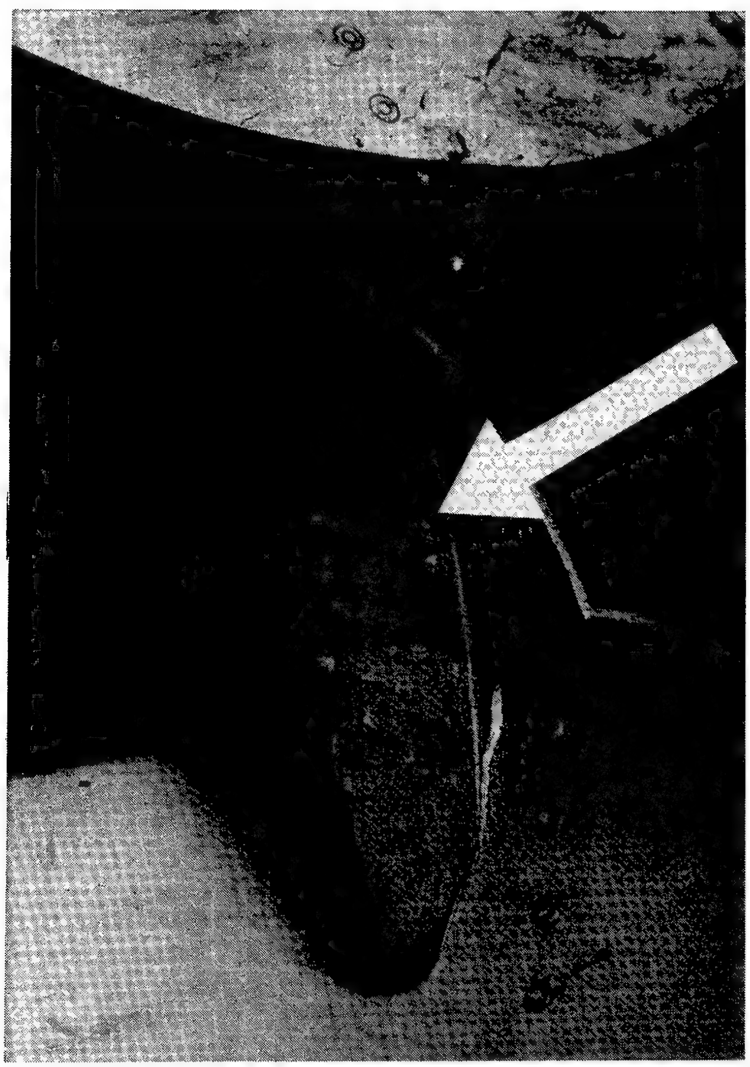


Heart-shaped nodes at the distal part of the barbules; Goldeneye Bucephala clangula (165x)

On the basis of these and similar characteristics, an identification-key has been made (which shall be published before long). with the help of this key (combined with the old macroscopic method), 150 recent bird-collisins have been analysed . The result is a large decrease in unidentified feather-remains (table 2).

Table 2. Identification-results 1975-79 (microscopic and macroscopic)

	number	percentace
species	63	43%
probable species	-	-
family	42	28%
probable family	-	-
order	41	28%
unknown	2	1%



Microscopic examination of scraped feathers (combined with the macroscopic method showed that in this collisi a Golden Plover (<u>Pluvialis apricaria</u>) was involved.

AD F616098

BSCE 14 / WP 20

The quality of identification: its effects on birdstrike statistics

L. S. Buurma & T. G. Brom

introduction

In order to reduce the chance of damage and risks due to collisions between aircraft and birds it is essential to gather knowledge on the birdspecies concerned. Not all birdspecies are equally dangerous to aviation. They differ in numerousness, weight, behaviour and their specific ecological position in nature. Considering the improvement in aircraft construction as well as in bird avoidance (detection by radar), bird removal and making the airfield environment unattractive to birds we therefore have to know what species actually cause damage.

Although this necessity is generally accepted it is as a rule rather difficult to establish the name of the species. Collisions just outside the airfield or "en route" and the occasions when the bird entered an engine usually provide only bledsmears and/or minuscule or totally destroyed featherremains. As a consequence, the frequency distribution of hidden species will be easily biased by the nearly complete bird corpses that can be recognised quickly and generally are found especially after birdstrikes on airfields and not "en route". Moreover, both pilots and ground personnel recognise certain species more easily than other birds.

To avoid this type of bias the Royal Netherlands Air Force takes advantage of the assistance in identification of the Zoological Museum in Amsterdam (ZMA). In addition in 1977 a special study on the possibility of using microscopic characteristics of feathers was initiated. In the meantime this study has presented an useful improvement of the only existing identification key. As a result many bird remains could be recognised as yet (see WP 19).

The aim of this contribution is to show how the introduction of this improvement in identification affects bird strike statistics of the RNLAF. Although this air force is rather small, and although as a consequence birdstrike numbers are limited, a comparison of the results over the last five years produces some remarkable results. The approach differs fundamentally from that of Rochard & Norton (1977) who did not include the aspect of damage and the proportion of birdstrike reports without remarks on identified bird remains. Further, an important point is that in the relevant years the air force flew with the same types of jet aircraft during roughly the same number of flying hours.
In view of a possible shift in emphasis on our birdstrike prevention programm, the RNLAF is interested to know your criticism upon our interpretation, and, secondly, wishes to promote the method of professional identification and careful analysis.

improvement in the identification of bird remains from 1974 till 1978

Figure 1 shows the proportion to which safe identifications increased: from 5 % in 1974 to 52 % in 1978, a factor 10.
Of course this result depends to a large extent on what we call "correct" and "unsure" identifications. We have to conclude that all identifications by those not known to be familiar with birds are unsure as long as we have no opportunity to check their observations. Several of these reports may be correct but we cannot separate them from the incorrect identifications that were frequently found. Many flash identifications of pilots result in remarkable bird names while in fact pilots are only able to say that the bird was small or big and looked black or white. Table 1 illustrates the increase in the number of bird species with the proportion of identifications by ornithologists.

Apart from the Zoological Museum our bird controllers, on duty at six jetfighter airbases since 1976, also play an important role in the improvement in the reporting system. On the one hand they can look for nearly complete bird corpses on the runways after local birdstrikes (excluding birds smashed to the ground due to the slip stream of the aircraft), on the other they get possession of the minuscule featherremains before they are washed off the aircraft. In spite of much propaganda even now we have to admit that many menbers of the groundcrews do not realize that even the smallest featherremains are useful. Only due to the alertness of the bird control units did these bird species indicators arrive at the museum.

From figure 2 it appears that the biggest advantage of the ZMA identifications relates to the damage cases. Over 70 % of these accidents are properly documented thanks to the microscopic and macroscopic museum analysis. We have to realize that the proportion of damage strikes increases with the speed of the aircraft and therefore roughly also with the flight altitude (figure 3) while the chance of finding easily recognisable bird remains outside the airfield is small. But fortunately thanks to the damage caused some small featherremains can nearly always be found upon rough structures near cracks in the skin of the aircraft.

speed of the aircraft versus weight of the bird

Knowing the official name of the bird means that we have at least a clue as to its weight (see ornithological manuals).
Since 1977 and 1978 produced a high proportion of useful data in figure 4 we compared the speed of the jetfighter and the weight of the bird with the damage caused by the collision. Clearly the birdstrikes consist of two groups: "at and around airbases" (as a result of the always present local bird population) and "en route" (due to the many hours of low level training flights and bird migrations in higher air layers). Both this figure and figure 3 show the remarkable difference in the proportion of damage cases. According to the physical laws this is ascribed in the first place to the speed of the aircraft. Strangely enough, however, even light birds frequently cause damage. Especially this category of birds would largely remain undetected without microscopic analysis.

In civil aviation, spending a smaller proportion of flying time in the air layers of the birds compared to airforces, the importance of the "en route" group is rather small. However, also to civil aviation the

bias discussed in this paper may comprise a warning. The damage ratio is primarily a matter of aircraft speed while the bias through reporting standards is highly connected to the chanee of finding complete bird-corpses. So, a sharp distinction must be made even between collisions above the runway and ones just outside the airfield.
Several RNLAF pilots noted repeatedly to be even more afraid of singly soaring birds at some altitude (including gulls) than of flocks on the ground.

bird species and damage

Apart from their weight the type of bird itself also seems to affect the chance of damage (figure 5). Although on part of the species included the number of reports is very small some surprising results were obtained. As already has been said the weight of the birds shows no general correlation.

Heavy game birds like pheasants (and some other groundbirds that were not included because the number of collisions was smaller than five) caused no damage. Swifts and starlings, however, were highly dangerous despite their light weights. Within the group of the gulls, oddly enough, only one out of ten herring gulls (a heavy species that frequently visits one of our airbases) caused damage whereas the two smaller species (black headed gull and common gull) ranked "normal". Pigeons appeared to be really dangerous but the most dangerous species of all was the buzzard.

The differences must be explained primarily by the behaviour of the birds. One important factor is their high flying activity causing them to enter the airlayers where aircraft reach high speeds. In this respect it is clear that swifts and pheasants constitute the extremes. The extent of being a migrant may also play a significant role. But we should not exclude the possibility that some bird species (or age groups) avoid aircraft on the basis of inherited skill and learning. Why are there, for example so few data in our files on the numerous crows?
Evasive actions among birds approached by aircraft have been frequently reported while Bellrose (1971) speculated on possible differences between larger and smaller night migrants, the first being most succesful.
And do buzzards just like the golden eagles in Switzerland (Bruderer, 1978) behave aggressively towards aircraft?

Finally, we wish to call your attention to the role of gulls in threatening flight safety. Although we wholly agree that gulls constitute a major danger, we have to conclude that their share in many statistics might frequently been overrated because of their conspicicusness and occurrence on airfields. In our analysis their proportion among damage strikes decreased considerably after improvement in the reporting system (figure 6). If we compare 1974 plus 1975 for all bird strikes (incidents and accidents together, ten ZMA identifications left out) with 1977 plus 1978 (only damage cases, seven unsure identifications left out) we find that the proportion of gulls decreases from 60 % to 32 % !

conclusions

1. The relative importance of different bird species colliding with aircraft changes if we improve identification technics and put our main concern on the birdstrikes with damage.

2. The strongest bias will be caused by overrepresentation of
   a) easily recognizable birds (e.g. white and big ones) and
   b) rather intact bird corpses to be collected easily, especially in case of birdstrikes above the runway.

3. Although data on birdstrikes that did not result into damage may provide information on potential hazards these data are extra vulnerable to the above mentioned biases and, therefore, they should not be mixed up with the analysis of damage cases.

4. If reporting facilities are limited it seems better to focuss all attention to bird strikes with damage in stead of doing everything a little bit.

references

Bellrose, F. C. 1971 The distribution of nocturnal migrants in the airspace. The Auk, 88: 397 - 424.

Bruderer, B. 1978 Collisions of aircraft with birds of prey in the Alps. BSCE 13 / WP 5

Rochard, J. B. A. & N. Norton 1977 Birds killed by aircraft in the United Kingdom 1966 - 76. BSCE 12/World Conf.on Bird Hazard to Aircraft Paris, october 1977. WP 4

BIRDSTRIKES AND IDENTIFICATION

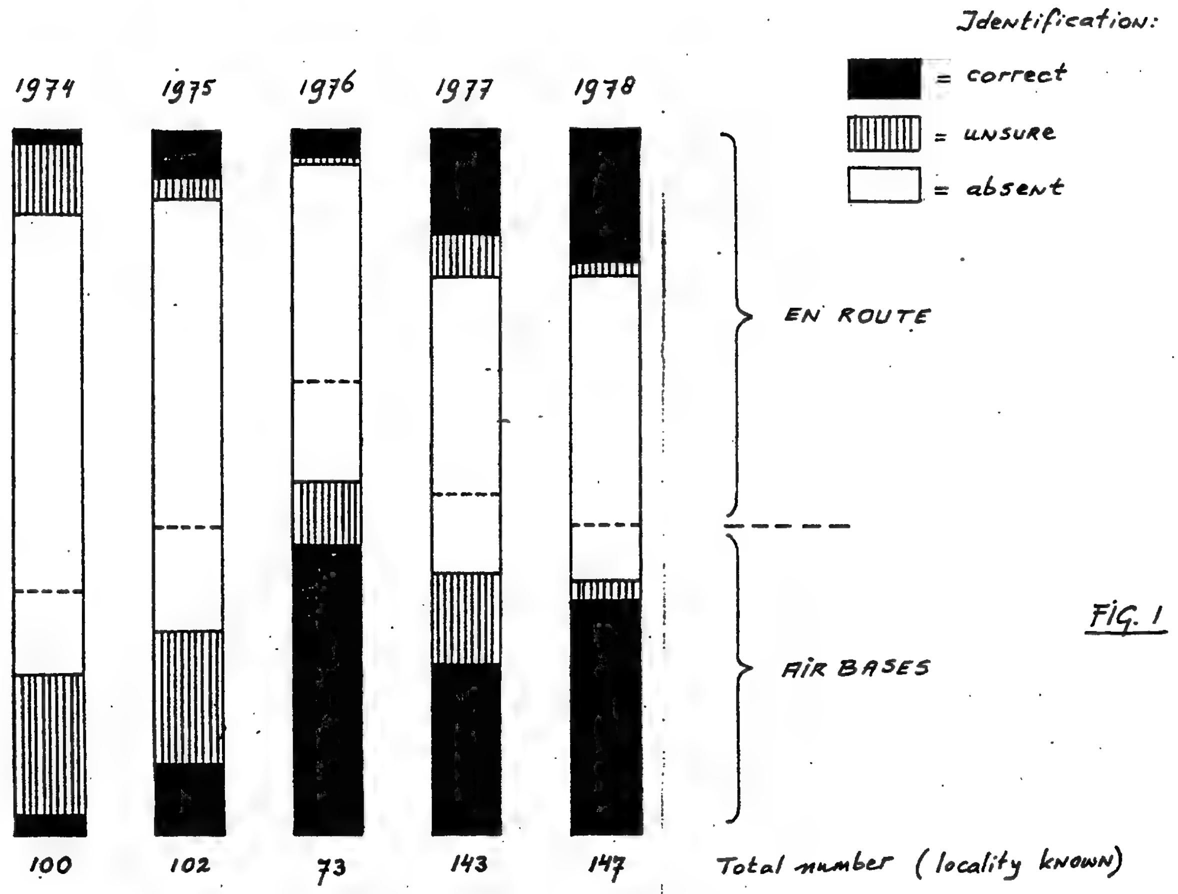


FIG. 1

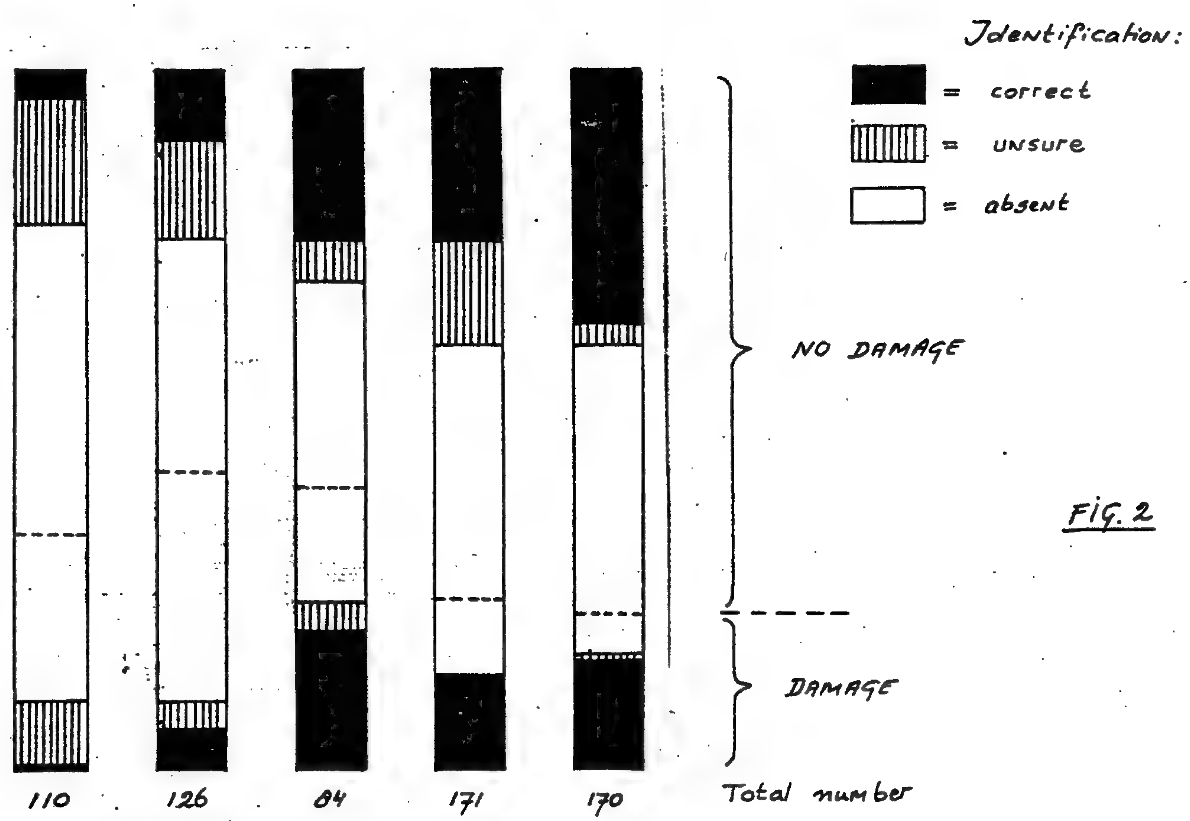
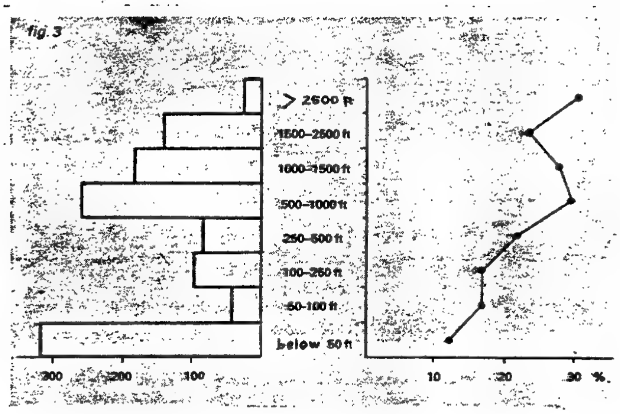


FIG. 2

Table 1

	1974	1975	1976	1977	1978
number of species reported	7	14	12	29	22
proportion (%) of "correct" identifications of all reported birdnames/birdgroups	14	49	82	72	93

including microscopic method



Total number of birdstrikes (all types of aircraft) over ten years and the percentage of cases with damage per altitude class.

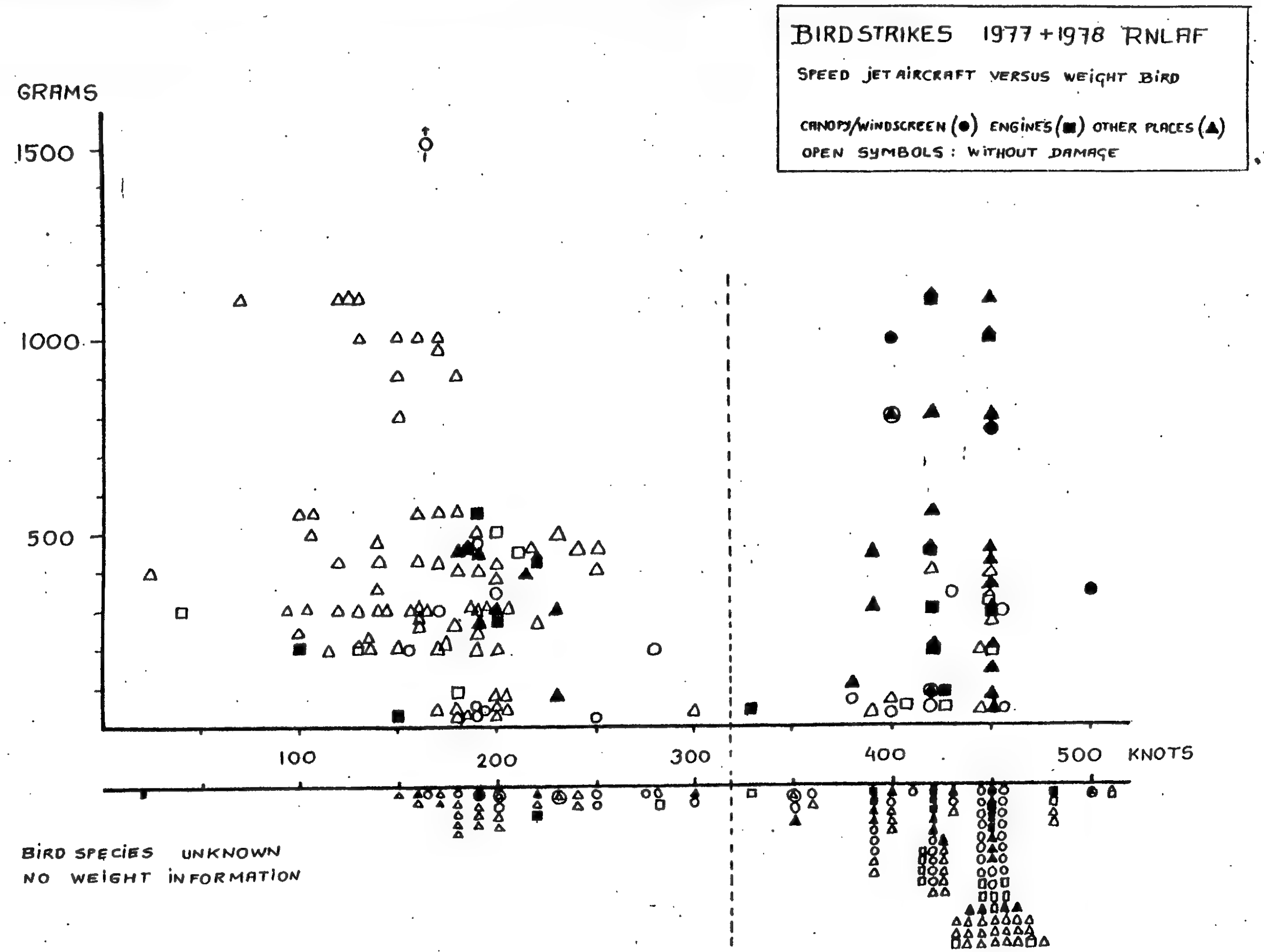


FIG. 4 "AT AND AROUND AIRBASES" "EN ROUTE"

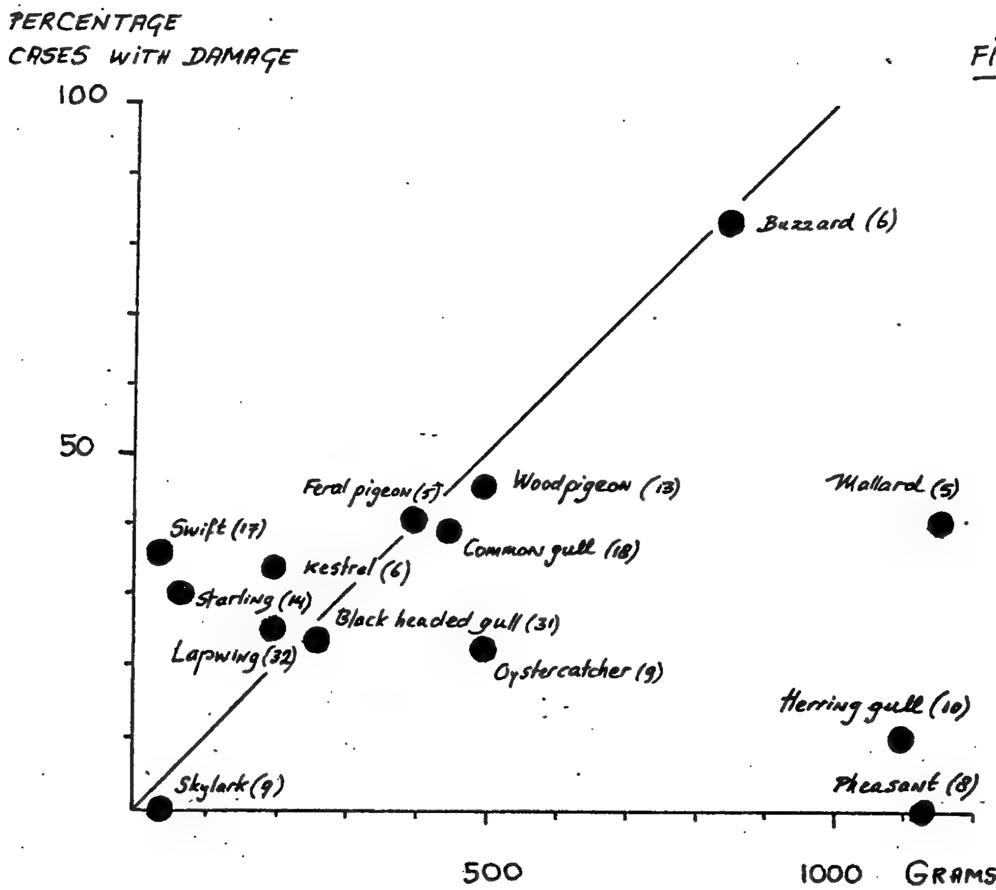

PERCENTAGE
CASES WITH DAMAGE
100
50
Buzzard (6)
Feral pigeon (5)
Woodpigeon (13)
Mallard (5)
Swift (17)
Common gull (18)
Kestrel (6)
Starling (14)
Black headed gull (31)
Lapwing (32)
Oystercatcher (9)
Herring gull (10)
Skylark (9)
Pheasant (8)
500
1000
GRAMS

FIG. 5

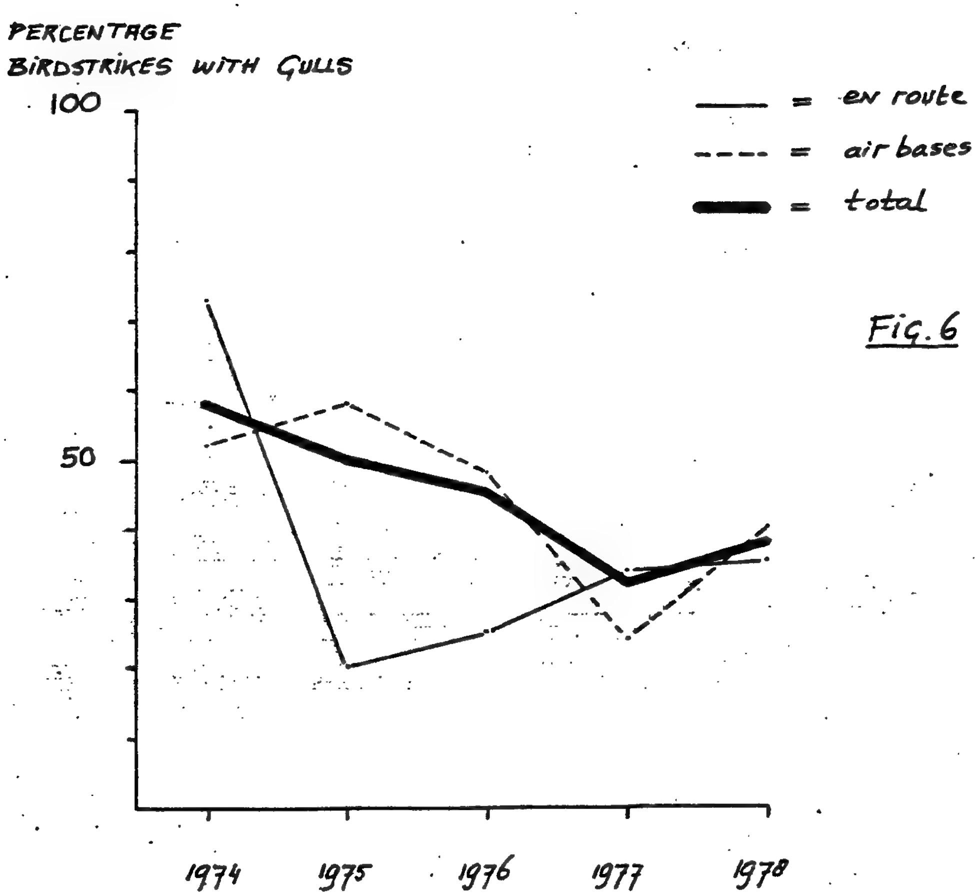

PERCENTAGE
BIRDSTRIKES WITH GULLS
100
50
— = en route
---- = air bases
▬ = total
1974
1975
1976
1977
1978

FIG. 6

AD F616 099

BSCE 14 / WP 21

Patterns of bird migration over The Netherlands: a classification illustrated with radarfilm

L. S. Buurma

A selection of filmfragments will be presented in order to illustrate the complicated patterns of bird migration as we do observe them at the radarscreen. Situated in the southern part of the North Sea bassin our airspace is a crossing area of N - S and E - W bird movements. It is not the aim of this contribution to present a full summary of all types of migratory activity occurring in The Netherlands: firstly because we do not yet fully understand all observed patterns; secondly, because we start to realize that the birds in the North Sea region behave rather flexible with respect to altitude and direction choice.

Our main intention is to show which problems we face in understanding not only how different radar settings influence the sample taken of the birds flying activity, but also how different behavioural responses of the migrants to weather, geography and light conditions influence the rate into which they enter the radarbeam and pass detection tresholds. Especially in the developement of electronic counting technics we have to know rather precisely where to put counting windows and how to interpret the measurements.

AD F 616 100

WP 22

cfm international

DEVELOPMENT AND CERTIFICATION

OF A RUGGED ENGINE

RELATIVE TO FOREIGN OBJECT INGESTION

The CFM56

By R.J. ARIZZI
SNECMA
PARIS
FRANCE

The Hague Oct. 1979

TABLE OF CONTENTS

LIST OF FIGURES

1. SCOPE - FOREWORD

The design of the CFM56 has been accomplished by SNECMA and General Electric working together under the coordination of CFM International which is a company established and jointly owned by SNECMA and G.E. for the certification sale and support of the CFM56 engine.

The CFM56 engine is of the class of 20 to 27.5 Klb thrust (9257 to 12 728 daN). This high by pass engine is typical of the new generation of medium sized engines.

When this project was initiated, in the early 70's, three main targets were assigned to the engineering groups :

- Low fuel consumption
- Low noise and emissions
- Ruggedness

The choice of an appropriate thermodynamic cycle, joint to an extensive refining, allowed to achieve a high thrust-to-weight ratio, low noise, low emissions and low specific fuel consumption.

The ruggedness was a matter of intensive testing and research in order not only to comply with certification requirements but also to achieve the lowest operating cost and the highest reliability.

The engine design (cross section) is shown in Fig. 1 : it consists of a dual rotor, variable stator, high bypass ratio turbofan powerplant designed for subsonic service.

The design and the configuration of the engine is based on obtaining long life, high reliability and easy access for line-maintenance.

The fan rotor consists of one full-diameter single stage fan and a smaller diameter 3-stage booster for the core engine flow.

All the fan rotor components are made of titanium.

The fan blades are designed for high performance, large

.../...

CFM56 Engine

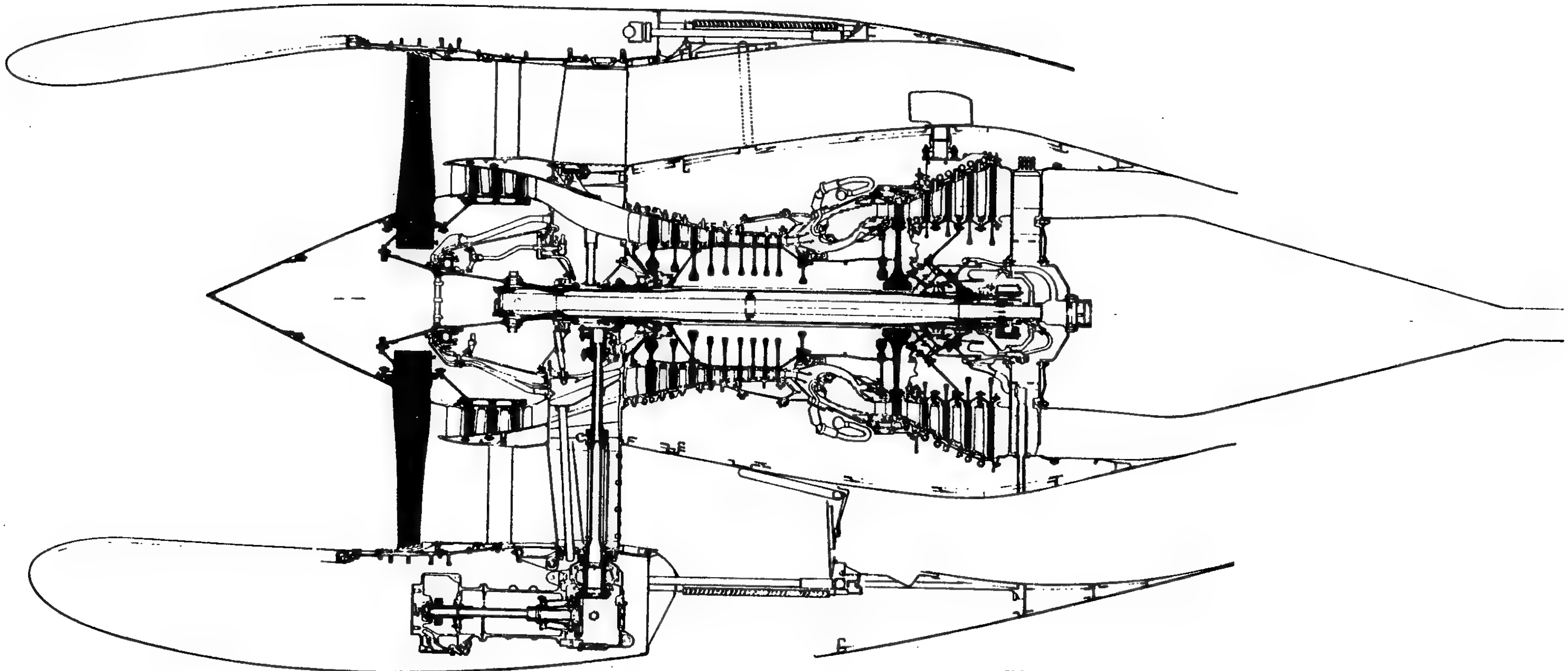


FIG. 1
CFM56 ENGINE
MOTEUR CFM56

stall margin and ruggedness. This difficult compromise was reached by adopting a specific feature, which is to our knowledge the first application in the world on a civil engine, namely the tip shrouds/snubbers.

The HP compressor is a nine-stage design, driven by a single stage HP turbine. The LP turbine consists of a 4 stage-rotor which drives the fan rotor through a concentric shaft.

2. CERTIFICATION REQUIREMENTS

Since the beginning of the project, both American and French Type Certificates were sought.

This implied that satisfactory evidence should be shown to Agencies in order to fullfill specific certification requirements such as FAR Part 33 for F.A.A. and JAR-E for DGAC.

In other words, the certification programme resulted from the addition of two sets of requirements.

Specifically, the foreign object ingestion activity was set up in order to include all ingestions required by the two Agencies.

The ingestion programme was divided into three families.

1 -One engine affected : No hazard to the aeroplane.
Engine shut down allowed

- One fan blade
- One 4 lb bird
- One tire tread

It is obvious that the secondary damage that could prevent from fullfilling the above criteria of compliance, were a direct result of the engine total out of balance.
It was then agreed by the Authorities that the demonstration could be done by analysis supported by component tests, and by officially running on the engine the most severe of the three above cases.

2 -More than one engine affected : 75 % of take-off thrust capability

- Seven 1.5 lb (medium) birds in less than 1 second (FAR 33 ; JAR-E required only 5)
- 4.5 OZ of gravel
- 31.5 OZ of sand.

.../...

3. More than one engine affected : no power loss

- Hailstones : - 25 off 2 in. diameter (51 mm)
  - 25 off 1 in. diameter (25,4 mm)
  - volley in less than 5 seconds
- Ice from inlet : no deicing during 30 seconds
- Water : 4 % of mass air flow.

It appears immediately that the above list of official ingestions to be performed was highly severe and that in the past no existing engine had to ingest so many foreign objects to comply with two requirements at a time.

But in the mean time it must be said that the potential risk of ingestion incurred by a flying engine is still actual and cannot be ignored ; the certification requirements were considered realistic. But by ingesting all the above objects, CFM INTERNATIONAL considered that this was not sufficient to show the actual ruggedness of the CFM56.

It was decided to widen the ingestion programme by adding extra severity tests, such as : ice slabs, spinner cone, several 4 lb birds etc., to the strictly required tests.

The final target was to show an extremely good margin, in terms of primary and secondary damage to engine parts, so not only certification requirements could be met but also high reliability, low refurbishment cost and high safety, by keeping the damage limited to the impacted components.

3. CFM56 INGESTION PROGRAM REVIEW

3.1 Scope - Objectives

The ingestion activity was divided into two main families :

- Development tests, mainly on components to limit the total expenditure
- Certification tests only on engines.

The test period extended over four years (1975 to 1978). All the development tests were performed in France at SNECMA Villaroche plant for rotating components and CEPr SACLAY plant for engine tests and on static cascades.

The objectives were, as said before, of two sorts :

- Certification : to demonstrate compliance with both FAR and JAR-E requirements (which increased the number and the severity of ingestions)
- Cost and reliability : to keep the secondary damage as low as possible and limit the expenditure to the replacement of the impacted parts.

As an exemple, the objective on fan blades under medium (1.5 lb) bird ingestion was : no fragments on impacted blades to avoid secondary damage to remaining blades by debris flying back and forth.

To fullfill the above objectives about 8 sets of 44 each fan blades were destroyed during the tests (i.e. about 350 blades) ; also a complete booster ingested several foreign objects during spin pit tests and at the end it was considered out of service.

.../...

All the bird ingestion tests were carried out using chicken bought from a local farmer : they were fed using wheat, corn, barley (no hormones) and were free in fields. They were killed at the right weight by suffocation using CO_2 gas, thus they kept in their body all matters, including blood. It is therefore considered that the hardness of their bones and the overall density were realistically duplicating actual bird characteristics although a little more severe due to wing lengths which were smaller than actual birds' ones.

3.2 Component tests

3.2.1 Static cascade tests

The first approach to ingestion activity was made by carrying out tests on static cascades of at least seven fan blades. These tests were run at CEPr Saclay using a vacuum gun and the first version of fan blade airfoil. One shot will be shown to you on the movie we have brought with us, and which will be commented by Mr Barrère.

The basic assumption was to duplicate engine running conditions i.e.

- impact velocity relative to blade
- impact angle relative to blade chord
- blade boundary conditions (tip and root)

by constructing the classical triangle of the axial, circumferential and relative-to-blade velocities.

The simulated aircraft speed was a typical take off maximum corresponding to 91 m/s (300 ft/s).

.../...

The following shots were performed :

- 6 shots of medium birds (1,5 lb, 680 g) from bottom to blade tips (91 m/s, 300 ft/s simulated)
- 7 shots of ice slabs (1 x 4 x 6 in, 25 x 100 x 150 mm) (sucked-in simulation)
- three shots of heavy birds (4 lb, 1810 g) (155 m/s, 515 ft/sec simulated).

Some fragments were generated at leading edge of blades when struck by the birds at a height of 60 % span or above.

Also tip shroud shingling (overriding) was experienced. Although not fully representative of engine conditions (no centrifugal field, for instance) it was forecasted that spin pin test could result in fragmentation for shots above 60 % span.

Figures 2 and 3 show typical fragmentated blades after bird strike.

3.2.2 Spin pit program

- Objectives

These tests were intended to establish the final design of the engine blading in order to successfully attempt the certification tests on a complete engine.

The two main objectives assigned to spin pit tests were :

- to confirm the static cascade test results in terms of fragmentation
- to define the change in design to blade airfoil, blade root and tip shroud to achieve the non-fragmentation target.

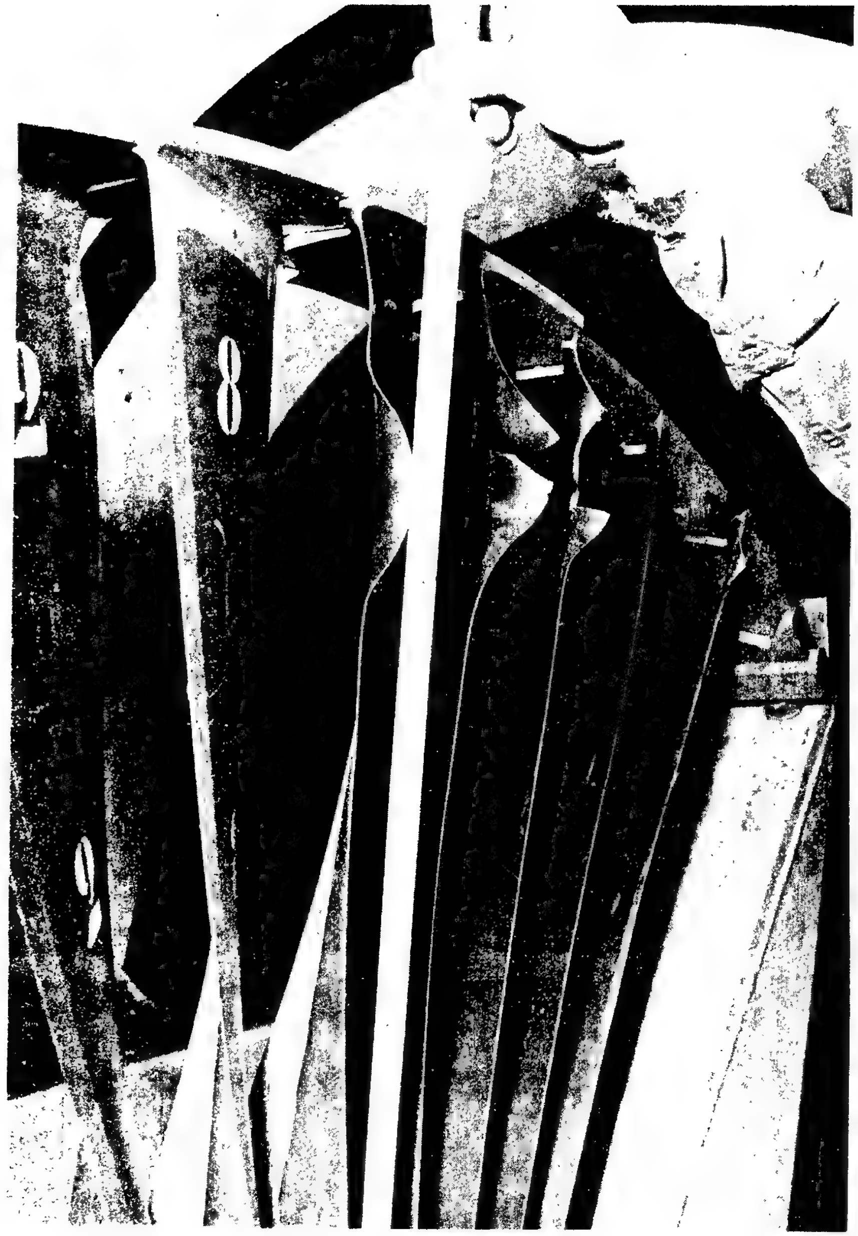


FIG. 2 - 1,5 lb bird strike on a static cascade
- Impact par un oiseau de 1,5 lb sur secteur statique

FIG. 3 - 4 lb bird strike on a static cascade

- Impact d'un oiseau de 4 lb sur secteur statique

- <u>Test facility and set up</u>

All the ingestion tests were performed in the vacuum since it was considered the aerodynamic loads were negligible compared to the loads generated by the high energy impacts.

One vertical spin pit was used for all the medium birds, ice slabs, tire tread and hail-stone shots. One horizontal whirligig was used for the heavy bird shots.

The test set up is driven by electric DC motors through a gearbox, thus very accurate driving speed can be set.

The vacuum is generated by pumps able to maintain the pressure level down to 1 Torr (1 mm of mercury, .040 in) or below.

Figures 4 and 5 show the arrangement of the test facilities.

The major portion of the test campaign was run using only fan blades since these are the engine components due to dissipate all the energy of the impact.

Some tests were performed using the fan and the booster but, as expected, the design changes in the booster were relatively minor and limited to airfoil stack up.

.../...

FIG. 4

Vertical spin pit

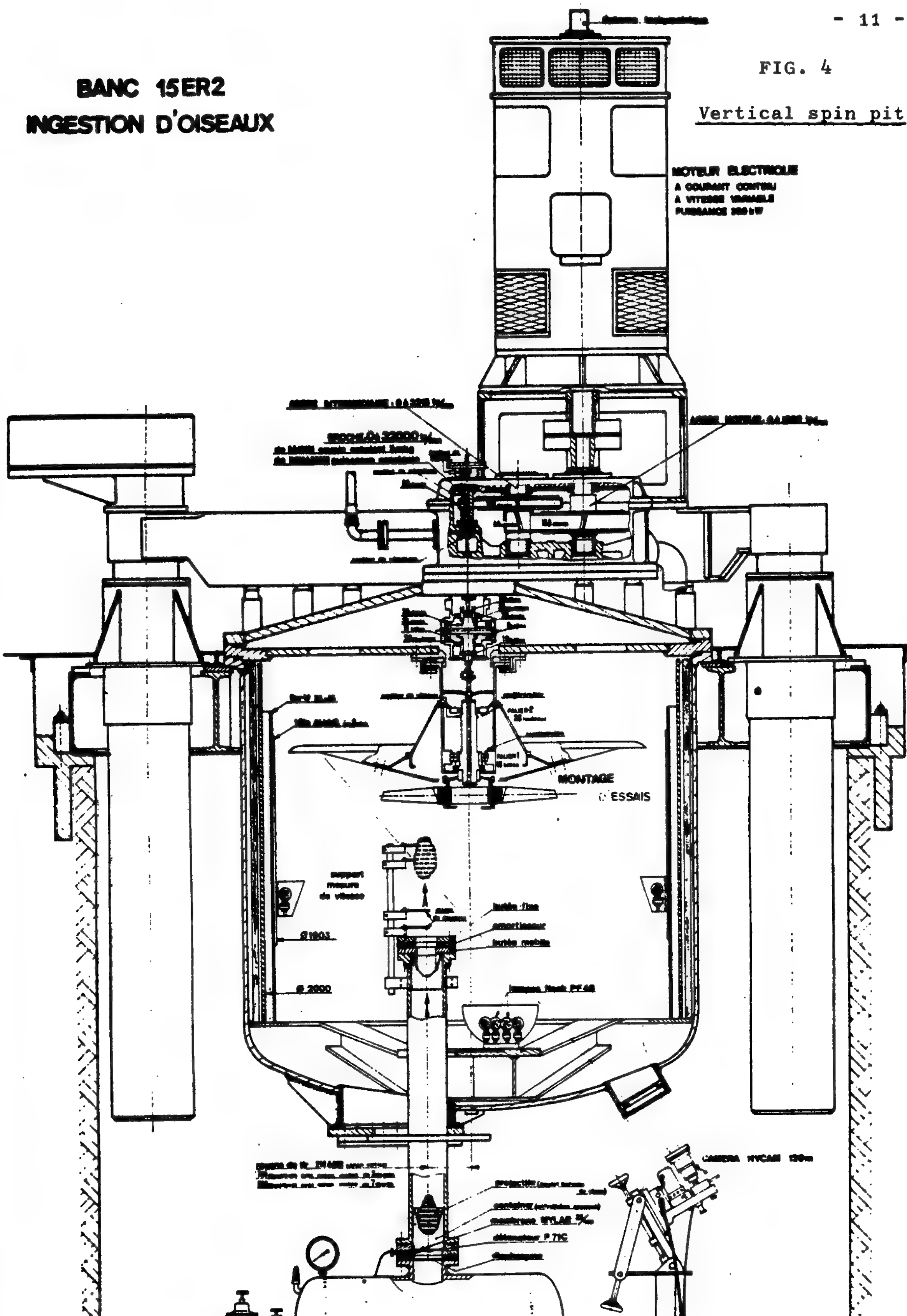
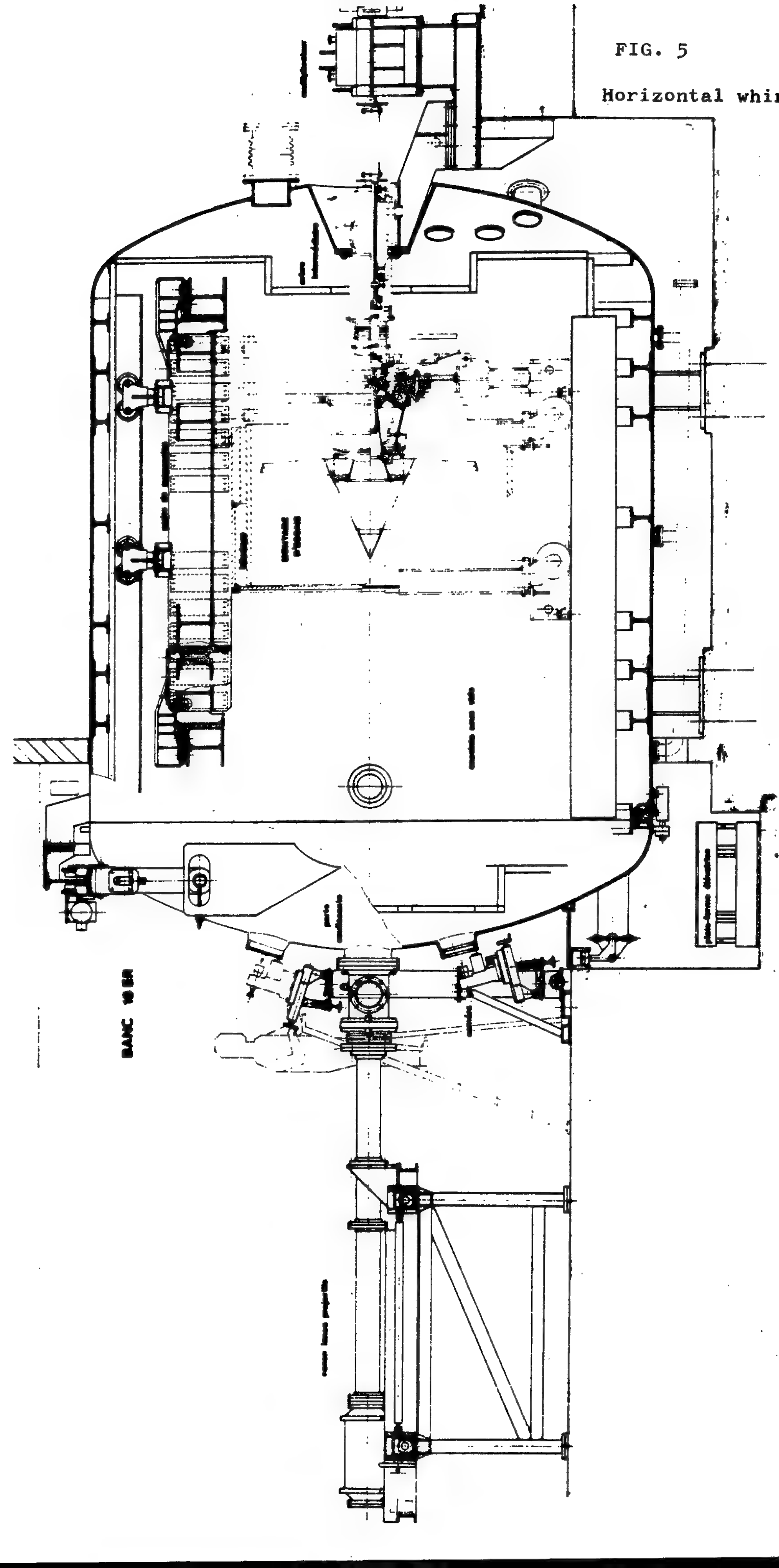


FIG. 5

Horizontal whirligig



- Test programme

The tests were to be performed at the following conditions :

. vacuum : 1 mm of Hg

. rotating speed : T/O max

. Missile velocity :

- medium birds : 91 m/s (300 ft/sec)
- heavy birds : 156 m/s (515 ft/sec)
- hailstones . 2 in dia 156 m/s
  . 1 in dia 217 m/s (715 ft/sec)
- tire tread : 15 m/s (50 ft/sec)
- ice slabs : 15 m/s

. Missile weights or size :

- medium birds : 680 g (1.5 lb) minimum
- heavy birds : 1814 g (4 lb) minimum
- hailstones : 25 and 50 mm dia (1 and 2 in.dia)
- tire tread : square piece of typical tire (A300B front wheel)
  10 x 10 in, 4 lb
  255 x 255 mm, 1800 g
- ice slabs 1 x 4 x 6 in
  1 x 3 x 16 in

As visible on fig. 4, the birds were wrapped up in a plastic sabot in order to obtain the most severe ingestion effect. All the other projectiles were fired in their natural shape.

The targets were set from spinner cone and blade root up to blade tips.

3.2.3 Spin pit performed tests

The overall extent of the ingestion activity resulted in the following impressive amount of shots :

- medium birds (1.5 lb)		41	shots
- heavy birds (4 lb)		20	shots
- ice slabs	1 x 4 x 6 in	7	
	1 x 3 x 16 in	1	
- hail stones 1 and 2 in dia		7	
- tire tread		7	shots
- fan blades	reduced size	1	
	actual size	4	
- spinner front cone		1	shot

As said before, the above tests were performed from 1975 to 1978 and about 350 fan blades were necessary to achieve a satisfactory design.
(Note : seven blades are hit at a time by birds or tires).

Also it is to be noticed that about 50 % of the above tests were performed using rotating cascades of at least 7 blades, the remaining being dummy blades. This minimum number of seven blades is necessary to correctly create the boundary conditions during the impact : testing with one or a few blades (less than seven) would have resulted in erroneous conclusions.

In the mean time, the use of rotating cascades lead to an important amount of preliminary tests in order to reach the high accuracy and reliability required

.../...

on timing necessary to attempt a strike onto the first or the second blade of the cascade. The reached accuracy is 0.1 milli-second.

3.2.4 Spin pit test results

- Medium birds

As forecasted, the first series of shots above 60 % span of fan blade resulted in rather significant fragmentation.

Fig. 6 shows the spin pit arrangement and
Fig. 7 the typical fragmentation when the bird is fired at 87 % span.

As a consequence, an intensive redesign activity was set up and new design blades tested in comparative conditions.

By locally adapting the thickness distribution it was possible to achieve a final design able to :

- avoid heavy fragmentation of fan blade L.E.
- keep the same stage performance
- keep the same stall margin

Fig. 8 shows two fan blades to type design after medium bird strike : bending and tears, no fragments.

The booster arrangement was reviewed to avoid axial contact between blades L.E's and vane T.E's. By just stacking up the airfoils in the right manner almost all axial contacts were avoided.

.../...

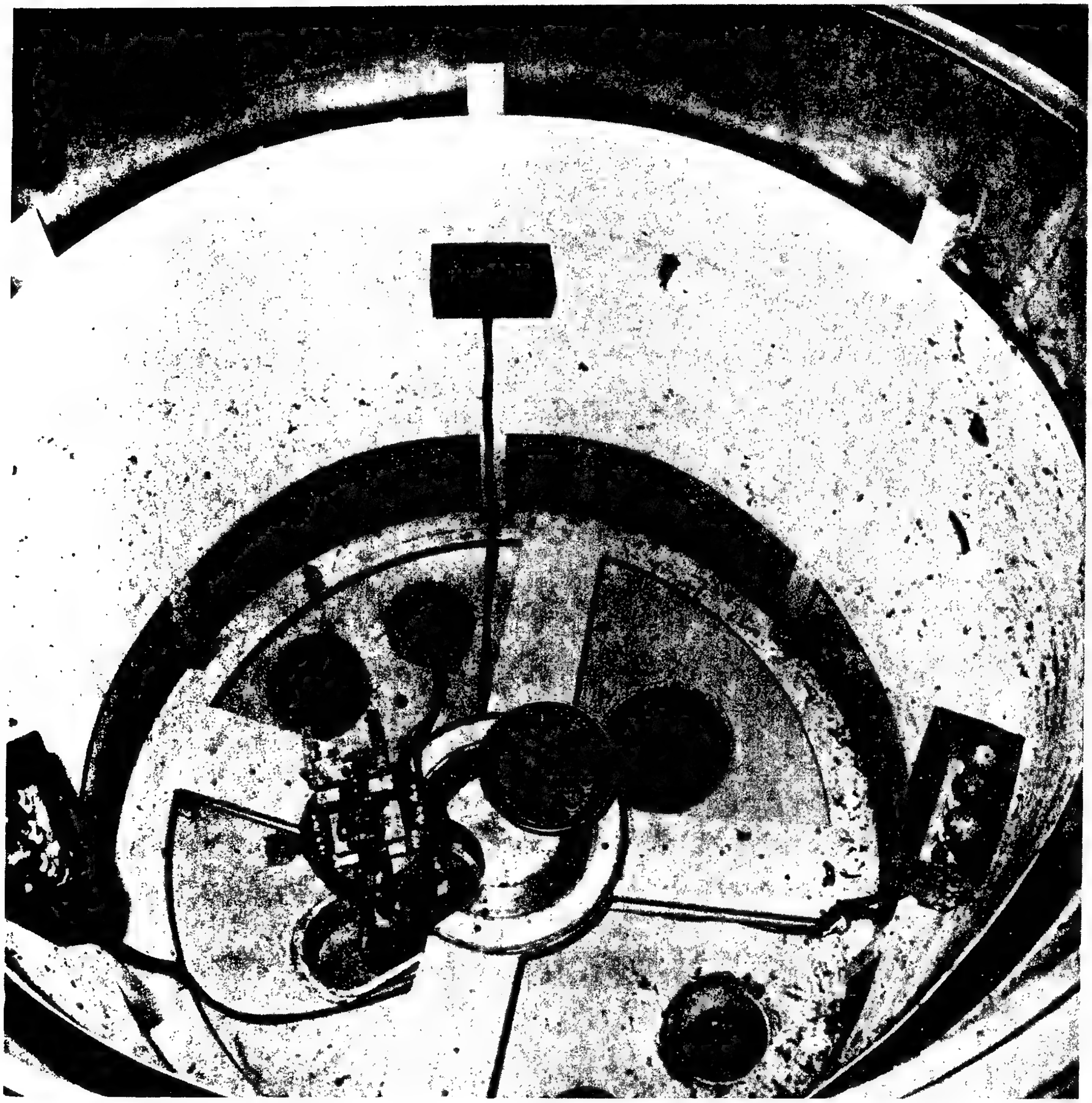


FIG. 6 View of spin pit after bird shot

Vue de la fosse après un tir d'oiseau

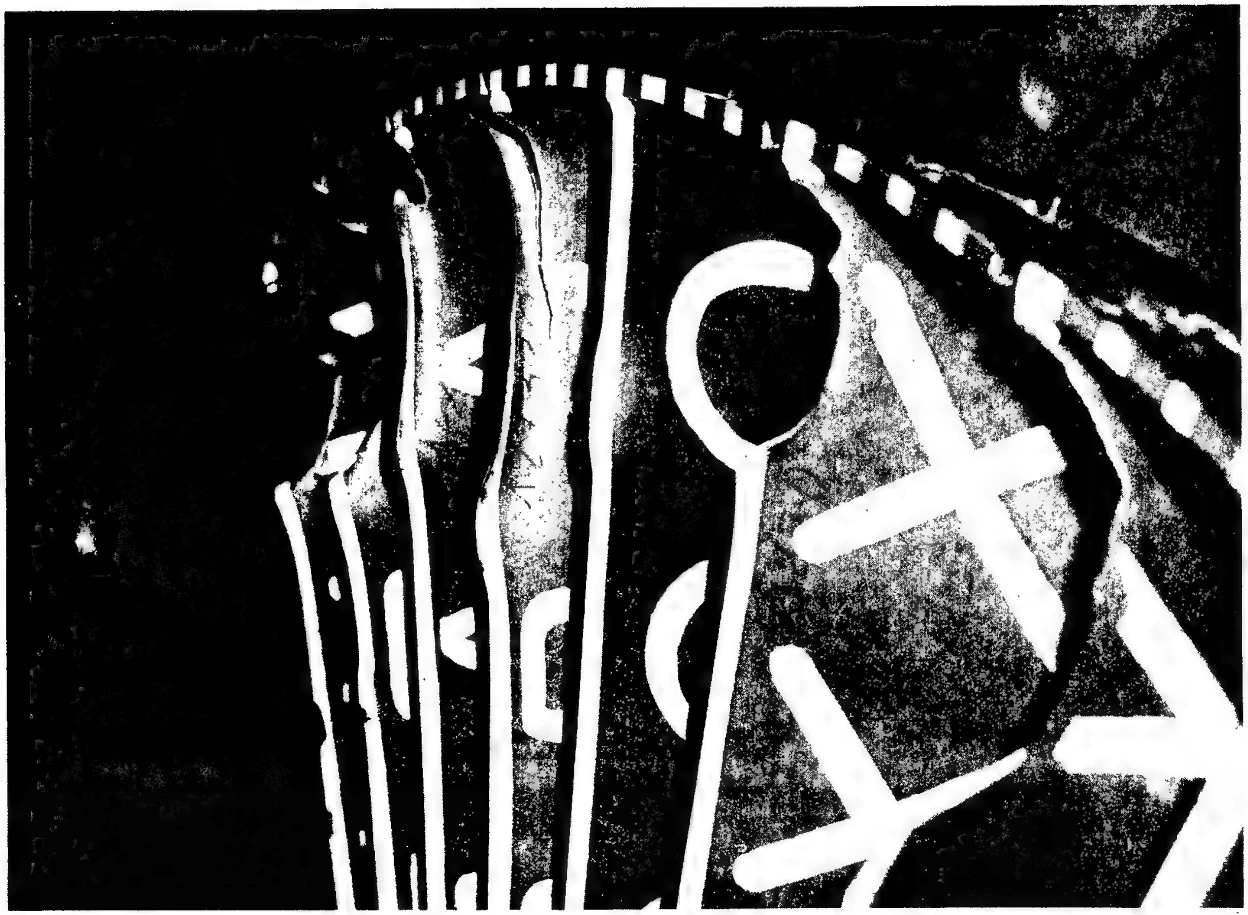


FIG. 7 - Fan blade initial version
Typical fragmentation by medium bird strike

- Aube de soufflante version initiale
Fragmentation typique par un oiseau moyen

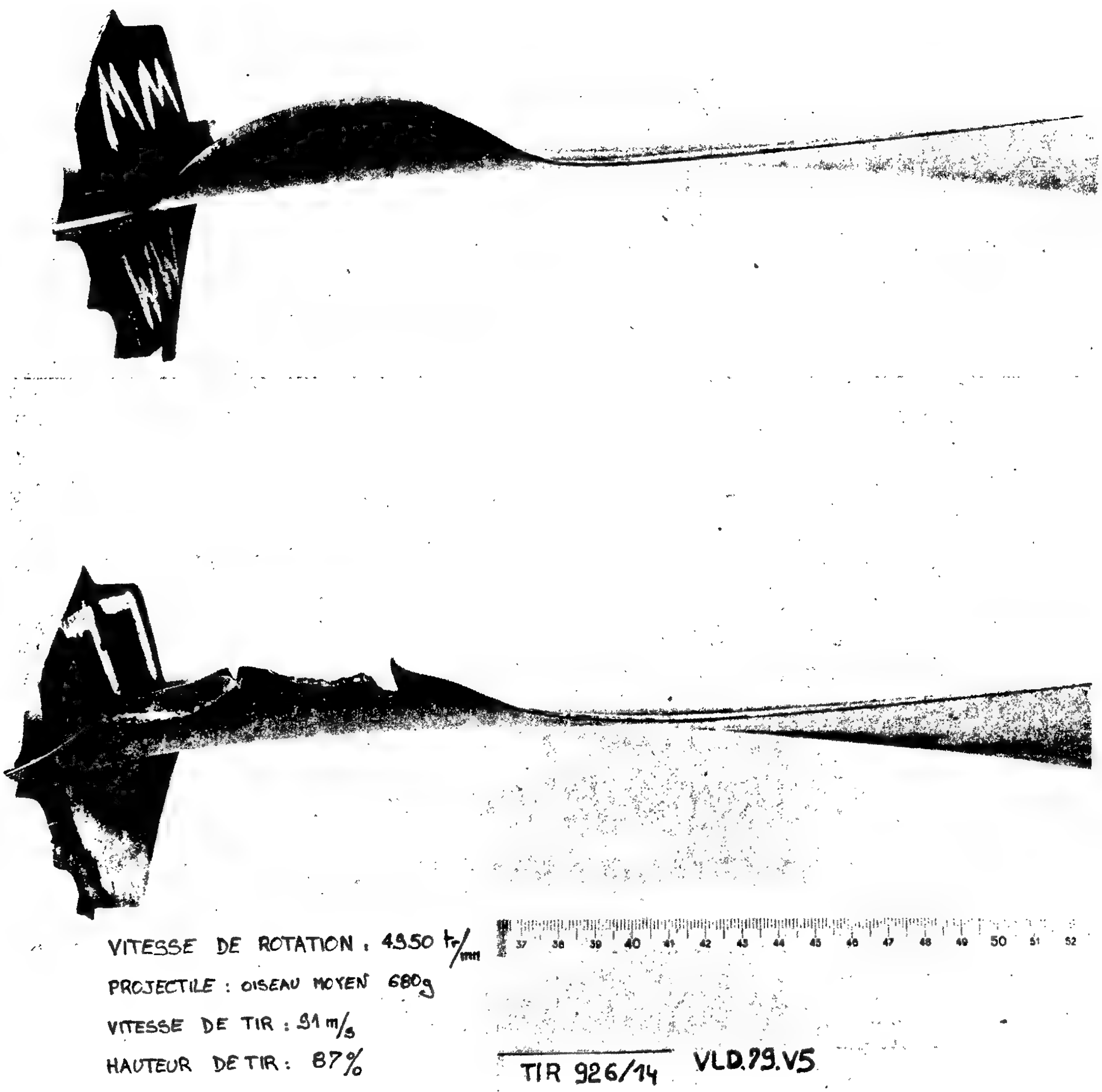


FIG. 8 - Fan blade to type design
Bending and tears by medium birds. No fragments.

- Aube de soufflante de certification
Pliure et déchirure par un oiseau moyen. Pas de fragments.

- Heavy bird

The fundamental improvement designed for the medium birds was also beneficial to heavy bird strike results : the fragmentation was obviously not avoided but the extent of it was considerably reduced and the total rotor out of balance limited to 11 % of an equivalent fan blade (5 to 7 blades are hit at a time). It is to be noticed that there is no fragmentation when the bird hits the fan blades at 50 % span or below.

Fig. 9 shows the typical fragmentation, limited to a small portion of the L.E., for a shot performed at 83 % span (the most severe).

When the 4 lb bird was fired at the blade root it was able to enter the booster flowpath. The resulting damages were : axial contacts between blades and vanes (bending is large when the chopped bird goes through), 4 blades broken at third stage.

When the bird was fired at the spinner rear cone (made of aluminum) the damage was such that the cone broke into hundreds of fragments thus allowing the front cone (made of kinel) to be ingested by the fan.

To evaluate the potential risk created by this supplemental "foreign" object the following extra severity test was decided.

.../...

FIG. 9 - Fan blade to type design
Typical fragmentation by heavy bird (4 lb)

- Aube de soufflante de certification
Type de fragmentation par un oiseau lourd (1810 g)

- <u>Spinner cone</u>

This test is in the film which will be shown to you later.

The cone ingestion velocity was about 15 m/s (50 ft/sec) as if it were sucked-in. Bolted to the base there was the front flange of the rear cone made of aluminum. This is a very realistic duplication of the actual case, should this happen.

As it is visible from the film, the cone is chopped up by the blades and at the end a big fragment (about 1/4 in weight) is ejected forward.

Fig. 10 shows the main fragments of the ingested cone after the test.

The damage to the fan blades was limited to small fragments of the leading edge. The total out of balance was below the 4 lb bird level : 7 % of an equivalent fan blade.

- <u>Ice slabs</u>

Seven shots were performed using the 1 x 4 x 6 in slab to establish the effect of the slab attitude when the fan blades are hit. Tests were done on first blade versions.

Fig. 11 shows the way the tests were run and the slab attitudes. One shot resulted in a small fragment but the slab velocity was higher than required (40 m/s instead of 15 m/s).

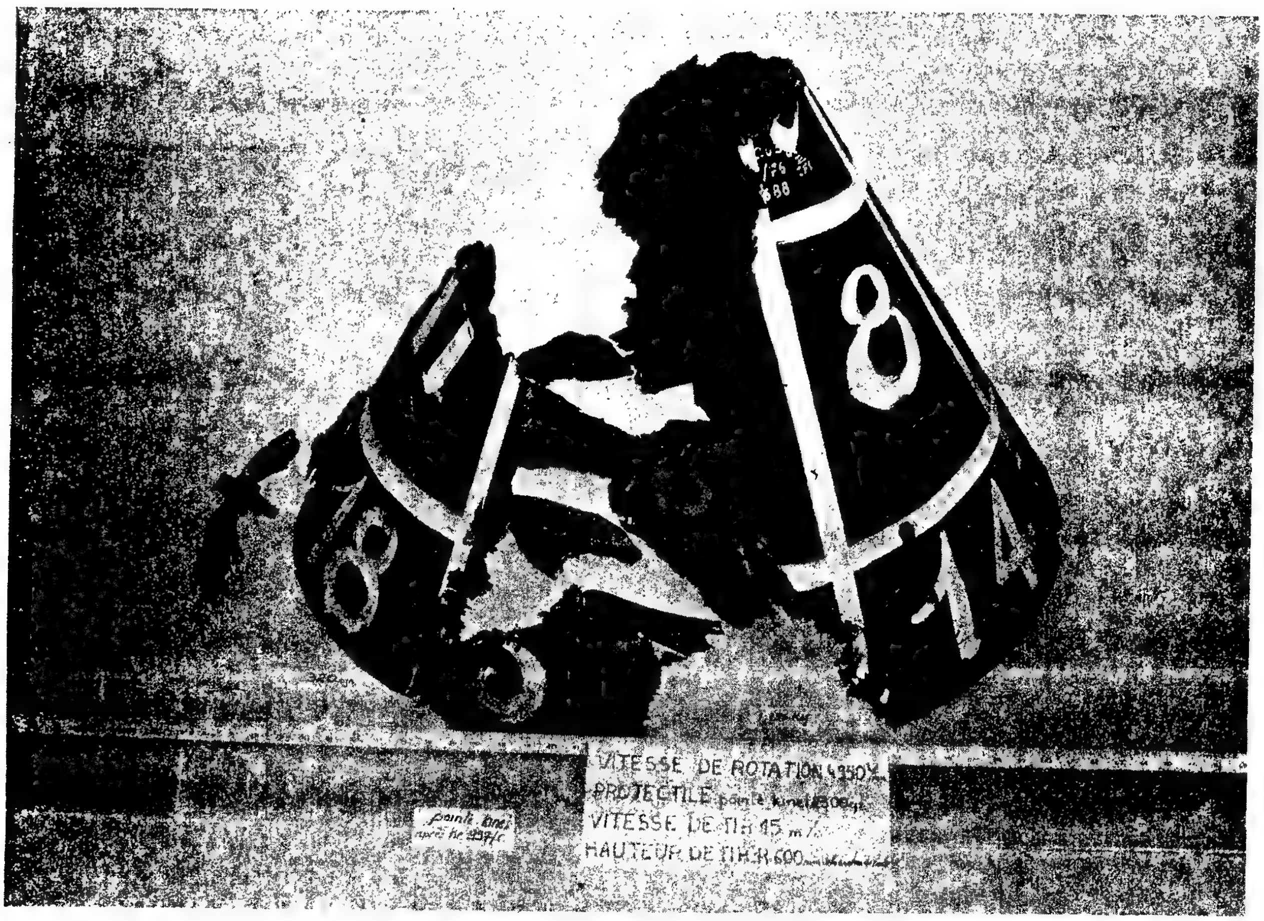


FIG. 10 - Spinner cone after being ingested by the fan
- cone de capot après avoir été ingéré par la soufflante.

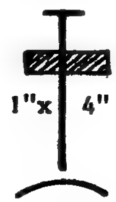
FIG. 11

- Ice slab ingestion
- Ingestion de barreaux de glace

PERFORMED SPIN PIT INGESTION TESTS

ICE SLABS

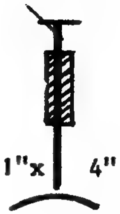
1. 1 IN X 4 IN X 6 IN



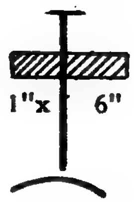
1 - 20 M/S = 66 FT/S : MODERATE L.E. BENDING (3 BLADES)

2 - 22 M/S = 72 FT/S : MODERATE L.E. BENDING (1 BLADE)

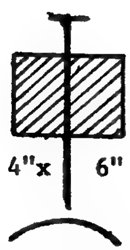
3 - 30 M/S =100 FT/S : MODERATE L.E. BENDING (2 BLADES)



4 - 17 M/S = 56 FT/S : NO DAMAGE

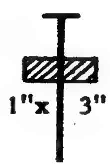


5 - 17 M/S = 56 FT/S : NO DAMAGE



6 - 40 M/S =132 FT/S : 1 FRAGMENT (33 GRMS) + 1 RADIAL CRACK (1 BLADE)

2. 1 IN X 3 IN X 16 IN



7 - 18 M/S = 59 FT/S : MODERATE L.E. BENDING (3 BLADES)

It is therefore difficult to find out wether the fragmentation was due to the slab aspect ratio.

- Hailstones

The shots were performed stone by stone to study the damaging effects at various shot spans.

They never generated significant damage.

- Tire tread

The tests were performed using the tread of a tire left on CdG runway by an A 300 B of Air France. By cutting off square pieces which size is the width of the tread we obtained a batch of real tires to be fired at fan blades.

The weight of the tire treads resulted to be 4 lb (1800 g) each.

Seven shots were performed at different spans on fan blade. The most severe damage was found for a shot at 75 % span where the resulting out of balance was 0,5 % of an equivalent fan blade.

Fig. 12 shows one of the tire treads used for this series of tests : the piece of tire is rolled up and fitted in the plastic sabot, similar to the one used for firing the birds. A clever and simple system makes it to get deployed before hitting the rotating blades. After the test only chopped up slices are found at the bottom of the spin pit.

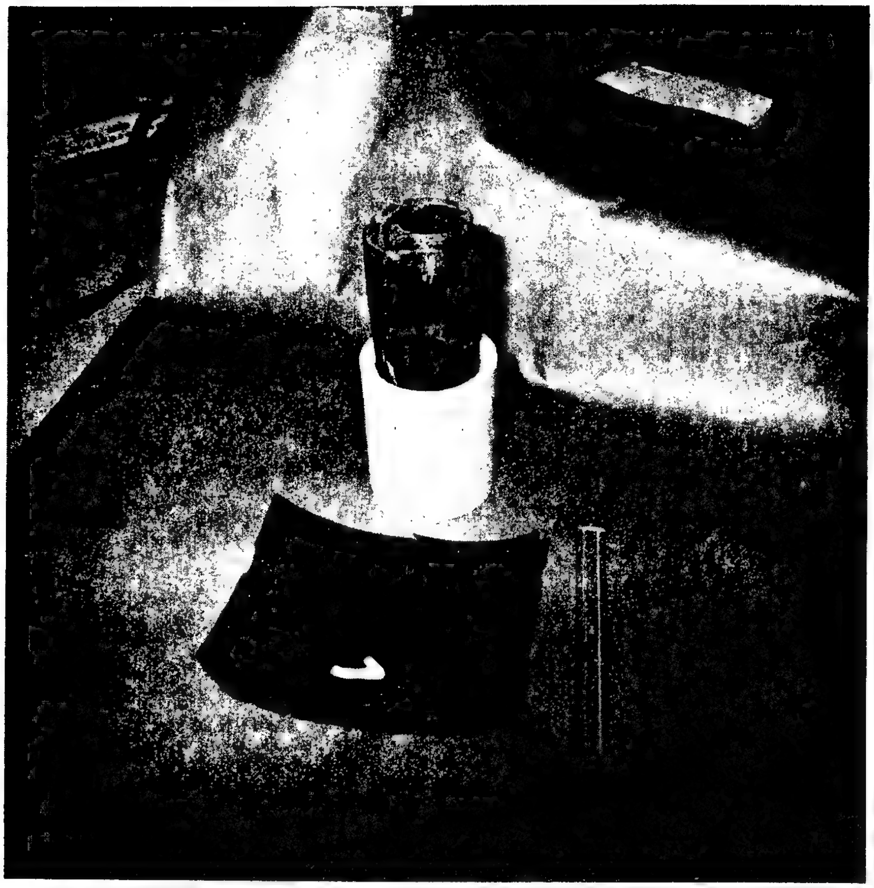


FIG. 12 - Tire tread before and after ingestion
- Chape de pneu avant et après l'ingestion.

- <u>Fan blades</u>

Several development tests of fan blade containment/ ingestion were performed before attempting the official test on a complete engine.

All the tests gave similar results.

Fig. 13 shows the released blade fragmentation as found after the test. The three blades correspond to three different tests.

The damage caused to the remaining blades were rather minor. The total out of balance resulting from such tests was limited to 1.1 to 1.48 equivalent fan blades.

3.3 Engine tests

Engine tests were fully carried out at CEPr facilities near Saclay (France). A specific open test bed was built to run ingestion and containment tests. Fig. 14 shows an overall view of the test site.

After the intensive development testing on components, the engine tests confirmed that the final design of the CFM56 was appropriate to cope with the severity of the F.O.I.

.../...

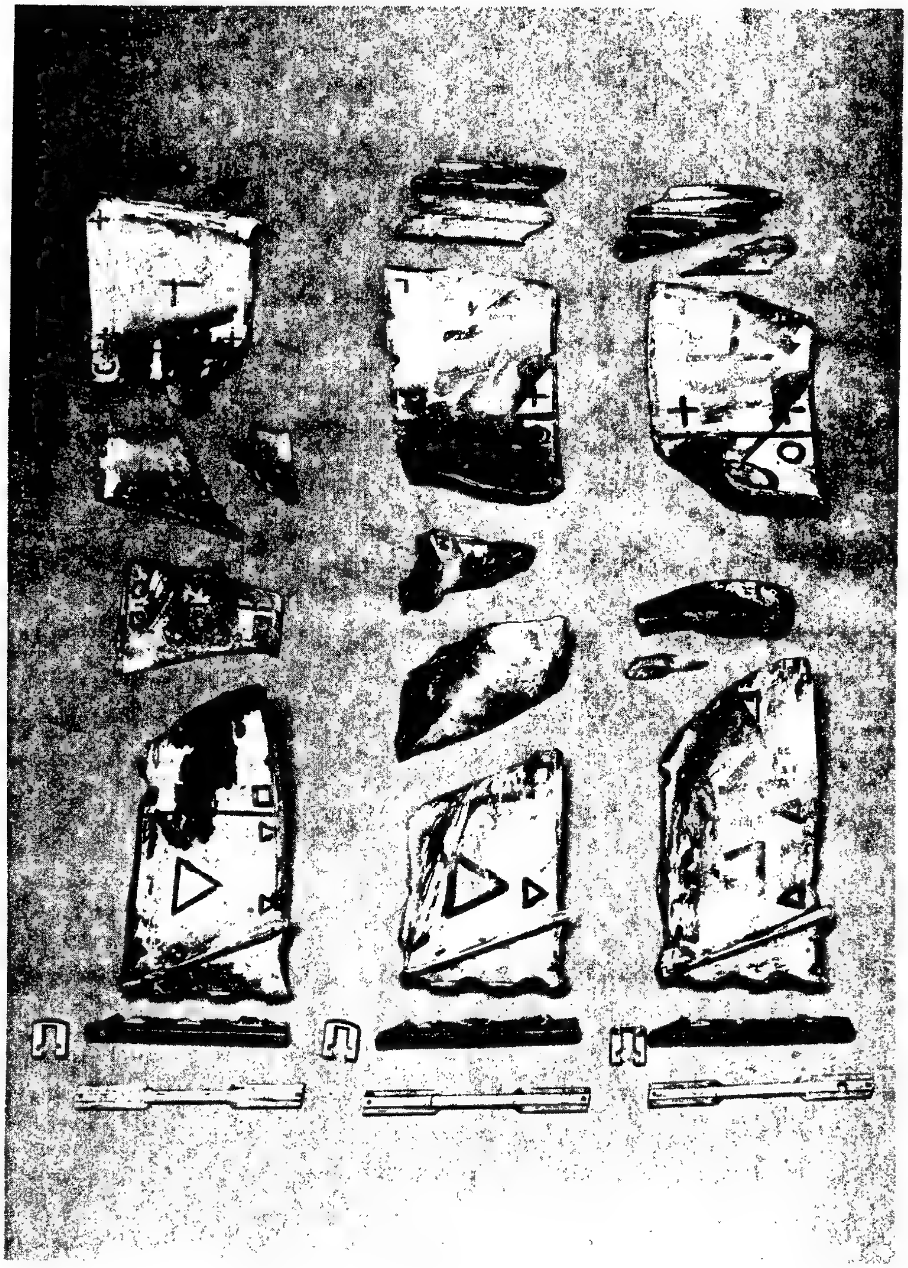


FIG. 13 - Released fan blades during three different containment tests

- Aubes de soufflante éjectées pendant trois essais de rétention différents.

The following tests were run over a period of three years :

- 4 medium birds up to 53 % span,, essentially into the primary flowpath
  2 ice slabs 1 x 4 x 6 in
  These tests showed that the duplication in the spin pit was almost identical : no fragmentation of fan blades, very limited damage to core blading.

- Seven medium birds, certification test.
  The test was extremely successfull : the engine recovered 98 % of its initial thrust with no throttle movement for 1 minute, then the engine demonstrated a 20 minutes endurance at 75 % of take off thrust. Excellent engine handling was also shown by acceleration and deceleration from idle to 75 % T.O. and back. Finally the engine was shut down and restarted with no difficulty.

- 50 hailstones (25 of each size) in a volley of less than 2.5 secs, certification test.
  This test was also successfull : no damage to the blading no power loss.

- 2 heavy birds (4 lb), essentially into the primary flow path.
  The engine behaved very well : no fragmentation of fan blades, all damage to core blades were contained, no fire.

- One fan blade out, certification test.
  The test was successfull. The total out of balance was limited to the released blade and the damage to the remaining blades limited to nicks and tears (several of them within repair limits).
  The engine showed no fire, no mounting loads in excess of specified limits, it was shutdown normally
  (This test is also shown in the movie).

- wooden shield
- pare-éclats (bois)

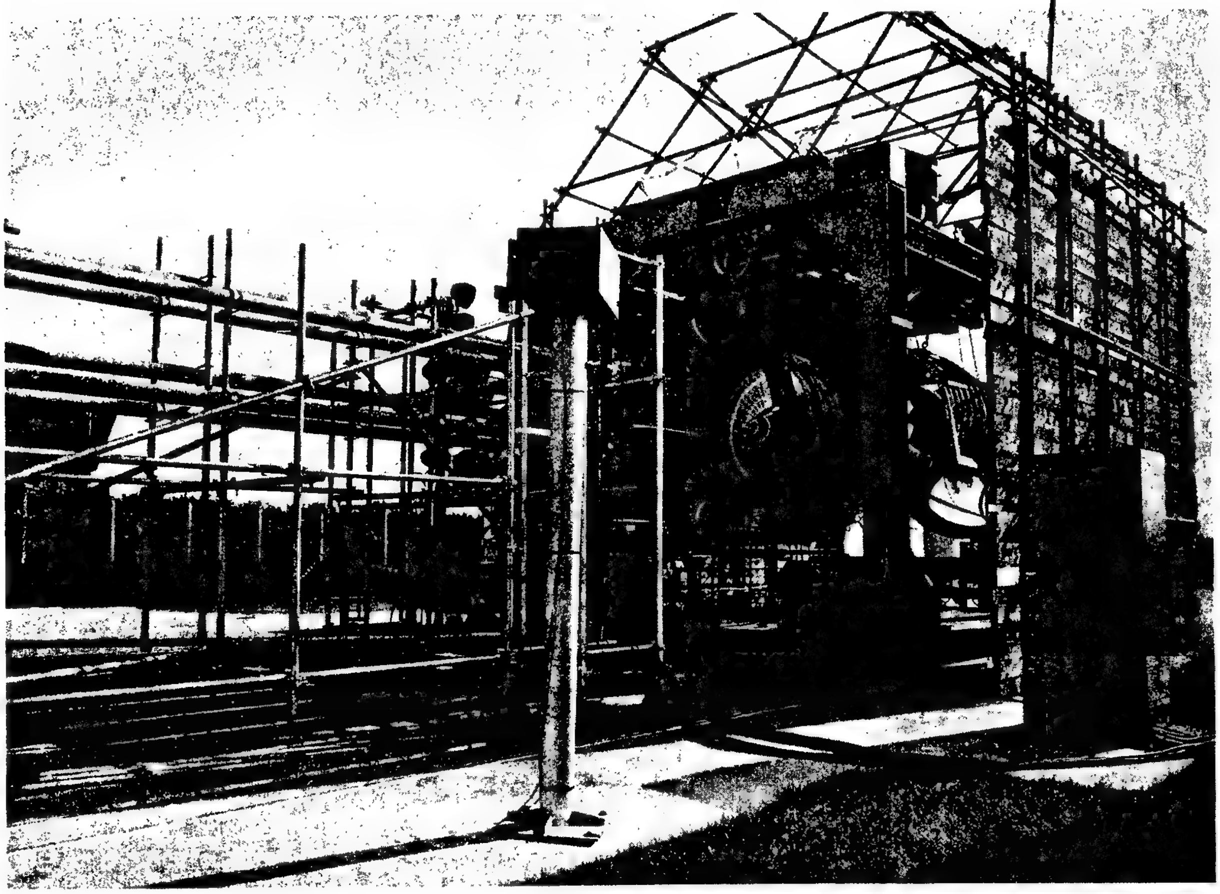


FIG. 14 - CEPr engine ingestion/containment test bed
- Banc moteur d'ingestion/rétention au CEPr.

4. CONCLUSION

We, at CFM International have always been very conscious of the hazards caused to engines by foreign object ingestion, and more specifically by bird strikes on fan engines.

The Certification Authorities have also recognized these hazards and that is why the current regulation are so stringent.

We have also looked upon it as very important to comply 100 % with these stringent requirements, not only for safety, but also for economical reasons. The necessary development tests to achieve these objectives has cost us a lot of time and money, but we believe that we are now entitled to affirm that with regard to F.O. ingestion as in all other respects, the CFM56 has been developed and tested without any kind of indulgence, and more severely than any other previous commercial engine.

Therefore you can see that the CFM56 engine has now achieved its third target : ruggedness.

Ruggedness is synonymous with safety and reliability for airlines and passengers.

Ruggedness means low operating cost through low maintenance costs.

Ruggedness also means minimum unscheduled removals due to F.O.D., with less impact in the form of aircraft departure delays or rescheduling.

The CFM56 is now a reality and is ready for a safe, reliable and long, long service.

This is what this engine is designed and built for.

BSCE/14
WP n°23

Solution propre à la France : sensibilisation des personnels

J. L. BRIOT

Service Technique de la Navigation Aérienne
246, rue Lecourbe - 75015 PARIS

Introduction

De nombreux auteurs ont déjà souligné l'importance de l'information des personnels dans la lutte contre le péril aviaire ; elle permet en effet d'atteindre trois objectifs :

1) sensibiliser les équipages sur les risques encourus et sur les moyens mis en oeuvre sur les aérodromes.

2) motiver et instruire les personnels chargés des opérations de surveillance et d'effarouchement des oiseaux.

3) obtenir davantage de comptes rendus de rencontres d'oiseaux.

C'est la raison pour laquelle l'administration française a décidé d'entreprendre, à partir de 1979, une campagne d'information intensive tant auprès des personnels navigants que des responsables aéroportuaires civils.

I) Information des personnels navigants

Des conférences accompagnées de projections de films ("L'Aile Apostrophe" et "Des oiseaux et des Anges"), ont été organisées dans les compagnies aériennes les plus importantes afin d'informer les équipages sur les risques encourus, l'intérêt des fiches de rencontre

.../...

d'oiseaux, les procédures d'évitement et les moyens d'effarouchement existants. De telles séances seront étendues aux compagnies de troisième niveau.

Plusieurs articles de vulgarisation ont été publiés dans des revues civiles et militaires couramment lues par les pilotes tels le Bulletin de Sécurité des Vols, Aviasport, Air et Cosmos...

Enfin un projet d'enseignement sur les risques aviaires, au moment de la préparation des brevets de pilotes de ligne et privé, est actuellement en cours d'élaboration.

II) Information des personnels des aérodromes

Une circulaire d'information intitulée "Consignes d'exploitation relatives à la prévention du danger présenté par les oiseaux dans le volume des aérodromes" (Voir texte intégral en Annexe), a été largement diffusée en mai 1979 sur tous les aérodromes français, dans les services de l'équipement et auprès des compagnies aériennes.

Cette circulaire vise essentiellement à faire le point sur les mesures à prendre dans le domaine du péril aviaire au niveau des aérodromes, et précise la répartition des tâches dans le cadre de la règlementation actuelle et de la législation française.

Par ailleurs, des séances d'information sont en cours de réalisation dans les districts aéronautiques métropolitains : ces séances permettent de sensibiliser les commandants et directeurs d'aéroports sur les moyens de lutte contre les oiseaux, et constituent un complément oral à la circulaire citée plus haut.

Parallèlement, des séances d'instruction des personnels des bureaux de piste et des services sécurité incendie et sauvetage, expliquant le maniement des dispositifs d'effarouchement des oiseaux, ont été menées sur les aéroports à risque aviaire élevé (Lyon - Satolas, Bâle - Mulhouse, Strasbourg, Lille etc...).

Enfin des cours ont été organisés à l'Ecole Nationale de l'Aviation Civile, lors de la formation des différentes catégories de personnels (Ingénieurs, Contrôleurs, Techniciens).

Conclusion

Un gros effort d'information a été réalisé cette année auprès des personnels des aérodromes puisque c'est à ce niveau

.../...

que l'on enregistre 75% des collisions oiseaux - aéronefs.

Parallèlement à cette action, des moyens importants en matériels pyro et électro-acoustiques, ont été affectés sur les aérodromes non équipés tels Bâle-Mulhouse, Lyon-Satolas, Strasbourg-Entzheim, Lille-Lesquin, Tahiti-Faa, Raiatea.

L'information des personnels navigants sera poursuivie l'année prochaine par de nouvelles conférences dans les compagnies aériennes, par la publication de trois types d'affiches (affiches "agressives" montrant la réalité du risque aviaire, affiches expliquant l'utilité des comptes-rendus de rencontre d'oiseaux, affiches d'identification des espèces aviennes) et par la refonte du film "l'Aile Apostrophe".

Annexe

Consignes d'exploitation relatives à la prévention du danger présenté par les oiseaux dans le volume des aérodromes

-----

Introduction

- Tous les oiseaux doivent être considérés comme potentiellement dangereux pour la sécurité de la navigation aérienne.

- 75 pour cent des collisions oiseaux-aéronefs se produisent dans le volume des aérodromes, durant les phases de décollage ou d'atterrissage.

- Il convient donc de prendre toutes les mesures nécessaires au niveau de l'aéroport et des installations, de façon à minimiser la présence des oiseaux sur la plate-forme aéronautique et dans son voisinage immédiat.

I - Répartition des tâches

I.1. Au niveau des aérodromes

I.1.1. - Prévention

Les Commandants d'aérodromes et les directeurs d'aéroports sont responsables des mesures à prendre pour réduire les risques de collision oiseaux-aéronefs sur l'aéroport.

Ils confient les tâches d'exécution aux personnels mis à leur disposition.

Ces tâches sont les suivantes :

- observation de l'activité aviaire sur l'aérodrome et ses abords immédiats
- mise en oeuvre des moyens d'effarouchement.

I.1.1.1. - Observations aviaires

Elles sont effectuées :

- par les contrôleurs d'aérodrome dans le cadre de leurs fonctions de surveillance de l'aire de manoeuvre,
- par les agents du bureau de piste et/ou du service sécurité incendie. Toutes ces personnes doivent avertir la Tour de Contrôle en cas de rassemblement d'oiseaux.

.../...

I.1.1.2. - Mise en oeuvre des moyens d'effarouchement

- les agents du bureau de piste et/ou sur certains aérodromes, du service de sécurité incendie sauvetage, sont chargés des opérations d'effarouchement par dispositifs mobiles d'emission de cris d'effroi et tirs de fusées explosives.

- les contrôleurs d'aérodrome sont chargés de la mise en oeuvre des dispositifs télécommandés de diffusion de cris d'effroi.

- certains agents spécialement autorisés peuvent être chargés d'effaroucher les oiseaux par des tirs de cartouches de chasse.

I.1.2. - Constats

Chaque fois qu'un impact d'oiseau est signalé par les équipages dans le volume de l'aérodrome, le Commandant ou le surveillant d'aérodrome doit :

- notifier la collision avec les oiseaux au même titre que les autres incidents, en rendant également le S.T.N.A. destinataire du message.

- établir le compte rendu correspondant sous la forme de fiche S.T.N.A. jointe en Annexe 1, la marche à suivre étant celle indiquée dans l'annexe 2. Ce compte rendu est indépendant de celui que le Commandant de bord et la Compagnie exploitante doivent produire s'il s'agit d'un aéronef de transport ou de travail aérien.

Lorsque l'I.G.A.C.E.M. décide de l'envoi d'un enquêteur spécial, est adjoint à ce dernier un représentant de la Division "Nuisances" du S.T.N.A.

I.2. Au niveau des exploitants d'aéronefs

Les pilotes sont tenus de signaler aux contrôleurs les rassemblements d'oiseaux rencontrés au roulage, en approche, à l'atterrissage ou au décollage.

I.3. Au niveau national

La Division "Nuisances" du S.T.N.A. fait la synthèse annuelle des incidents aviaires survenus sur chaque aérodrome conformément à la circulaire 20 283 - DNA/2 du 23 février 1965 ; cette synthèse est envoyée aux Directions Régionales, Districts Aéronautiques et Commandants d'aérodromes intéressés, ainsi qu'à l'I.G.A.C.E.M., Bureau enquêtes-Accidents.

A la demande des commandants d'aérodromes ou des D.R.A.C., les biologistes de cette Division réalisent les études ornithologiques et écologiques qui permettent de définir les actions à entreprendre sur le milieu, ainsi que les matériels d'effarouchement à installer pour résoudre localement les problèmes aviaires.

II - Information des équipages

II.1. En cas d'activité aviaire intense sur la plate-forme aéroportuaire ou dans son voisinage immédiat, les pilotes des aéronefs en approche, atterrissage ou décollage doivent être informés de la situation ornithologique locale par la tour de contrôle.

II.2. Ces informations concernent :

II.2.1. - Les rassemblements d'oiseaux fréquentant les plateformes aéroportuaires et leurs mouvements éventuels (observations réalisées par les personnels de

.../...

la circulation aérienne en service à la tour de contrôle, les agents des bureaux de piste ou par les pilotes.

II.2.2. - Les concentrations ou les déplacements locaux d'oiseaux dans les trouées d'approche ou de décollage (signalé par les pilotes ou par les cartes des mouvements aviaires publiées dans les MIA-AGA 047-048 (Voir Annexe II).

II.2.3. - Les mouvements migratoires signalés par message de Bird Warning ou par Birdtam (exemples en annexe IV).

II.3. La transmission de ces informations s'effectuera de la manière suivante :

II.3.1. Aéroports équipés d'un ATIS

II.3.1.1. Des informations claires, concernant des rassemblements d'oiseaux permanents, temporaires (mais réguliers) ou inhabituels, pourront être diffusées par ce dispositif automatique.

Exemple : - Risque de collision oiseaux particulièrement important sur l'aérodrome
- " " : rassemblement d'oiseaux 500 pieds sol verticale radioborne intérieure
- " " : migration d'oiseaux 1500 pieds sol verticale balise OYE

A la demande du pilote un complément d'informations sur la situation aviaire du moment pourra être fourni en radiotéléphonie par les contrôleurs en service.

II.3.1.2. Des informations nouvelles concernant des rassemblements temporaires ou très localisés d'oiseaux seront également transmises par les contrôleurs à leur propre initiative.

Exemple : - forte activité d'oiseaux près du seuil 25
- bande d'oiseaux rencontrée à 1500 pieds en approche de la 22 signalée par un pilote à 20 h. 35 TU

II.3.2 Aéroports non équipés d'un ATIS

Lorsque le contrôleur le jugera nécessaire, des informations précises concernant des rassemblements d'oiseaux sur la plateforme aéroportuaire ou dans son voisinage immédiat, seront transmises par radio aux équipages, au même titre que les consignes classiques d'atterrissage ou de décollage.

Exemple : - nombreux groupe d'oiseaux le long de la 04
- volées d'oiseaux en migration vers le Nord-Est verticale Outer Marker

III - Les techniques d'effarouchement des oiseaux

III.1. Méthodes classiques

Les méthodes classiques de dispersion des oiseaux sur les aérodromes comprennent : - les dispositifs mobiles, semi-mobiles et fixes d'effarouchement acoustique (diffusion de cris de détresse spécifiques)

.../...

- Les dispositifs d'effarouchement pyrotechniques (cartouches à double détonation).

III.1.1. Utilisation

- Ces techniques doivent être utilisées soit à la demande d'un commandant de bord ou d'un contrôleur, soit lorsqu'il est jugé nécessaire d'écarter un danger potentiel de rencontre d'oiseaux (exemples : présence d'espèces particulièrement vulnérables comme les mouettes, les rapaces ou les pigeons sur la piste, les voies de circulation ou les accotements ; présence de "carroussels" de mouettes ou de rapaces dans les trouées etc ...)

- Les dispositifs semi-mobiles ou fixes d'effarouchement acoustique peuvent être utilisés directement par les personnels chargés du contrôle d'aérodrome, grâce aux systèmes de télécommande installés dans les vigies.

III.1.2. Modalités d'intervention

- Les interventions auront lieu de préférence pendant les inspections de piste (surtout le matin, avant que les oiseaux soient très actifs ou dès qu'ils arrivent sur l'aérodrome) et dans les creux de trafic. Elles seront plus fréquentes après une forte pluie, pendant les périodes de tempête ou de neige, et, d'une façon plus générale, chaque fois que les conditions météorologiques seront favorables à l'incursion de nombreux oiseaux sur l'aérodrome (multiplier dans ce cas les inspections de piste sans hésiter à "harceler" les oiseaux à l'aide des moyens d'effarouchement disponibles.

- Si un dortoir (rassemblement nocturne d'oiseaux) se forme sur une plate-forme aéroportuaire, il est indispensable de commencer les opérations d'effarouchement dès les premières arrivées d'oiseaux afin d'éviter qu'ils s'établissent pour la nuit.

- Les interventions doivent être conduites avec une grande prudence en cas de de trafic aéronautique important ; un envol d'oiseaux mal dirigé, vers la piste en service par exemple, peut occasionner un incident grave. Pendant ces périodes, il convient de ne jamais intervenir si les oiseaux paraissent tranquilles, même s'ils sont posés sur les accotements de la piste en service (veiller au contraire à ne pas provoquer d'envol intempestif). On attendra un creux de trafic (10 minutes suffisent) pour éloigner les oiseaux à l'aide des procédés classiques d'effarouchement. Les interventions n'auront lieu qu'en cas de rassemblements d'oiseaux posés sur la piste en service ; les équipages seront avertis et le trafic retardé tant que la piste ne sera pas totalement dégagée. On choisira selon le cas l'une ou plusieurs des méthodes suivantes :

- Utiliser le véhicule d'effarouchement acoustique en s'approchant des oiseaux par une voie de circulation ou par les accotements, et arrêter les véhicule à environ 70 mètres du bord de piste ; puis mettre en marche le dispositif d'effarouchement (Ceci permet d'utiliser la réaction de "tropisme positif" : les oiseaux viendront survoler le véhicule avant de s'éloigner et la piste sera immédiatement dégagée).

En cas de nécessité, renforcer l'action de l'émetteur de cris d'effroi par des tirs de fusées pyro-acoustiques à double détonation.

.../...

- Envoyer une voiture de piste près de la concentration d'oiseaux et tirer des cartouches à double détonation dans le groupe, puis derrière le vol de manière à repousser les oiseaux en dehors de la piste.

- En période de chasse et/ou sur autorisation préfectorale, renforcer l'effarouchement en effectuant des tirs réels avec cartouches à plombs contre les pigeons, vanneaux, étourneaux, corbeaux et au besoin les mouettes (voir chapitre IV).

III.2. Autre méthode

- Lorsqu'un décollage doit avoir lieu après un creux de trafic important, le contrôleur peut conseiller au pilote de remonter la piste en service pour s'aligner compte tenu des possibilités d'exploitation de l'aéronef et des impératifs du trafic. En cas d'impossibilité ou de refus du pilote, une voiture de piste pourra aller vérifier que la piste est dégagée.

IV - La chasse et la lutte écologique

IV-1. Exercice de la chasse sur un aérodrome

La pratique de la chasse sur un aérodrome peut dans bien des cas venir compléter et renforcer les méthodes traditionnelles d'effarouchement des oiseaux. C'est pourquoi il est indispensable, que sur les aérodromes où les risques aviaires sont sérieux, l'un des responsables de la lutte contre les oiseaux au bureau de piste ou au SSIS, soit détenteur d'un permis de chasser.

On se référera à la circulaire AC n° 317 DBA du 2 février 1957 relative à l'exercice de la chasse et destruction des animaux sur les aérodromes civils de l'Etat, ainsi qu'à l'arrêté du 30 juin 1975 qui fixe les modalités de délivrance, de visa et de validation du permis de chasser.

IV.1.1. Pendant la période d'ouverture de la chasse en principe de septembre au premier dimanche de janvier), certaines espèces comme les pigeons, les vanneaux les étourneaux ou les corbeaux, pourront ainsi être tirées à plombs lorsque les métho- classiques d'effarouchement s'avèrent inefficaces.

Des battues visant à limiter la densité des populations de perdrix et de faisans quand elle est trop importante et qu'elle risque d'entraver la sécurité de la navigation aérienne, pourront être réalisées soit par la Société de chasse formée par le personnel de l'Aviation Civile quant elle existe, soit par les sociétés de chasse locales au titre de battues administratives (cf. Infra.).

IV.1.2. Pendant la période de fermeture de la chasse, certaines espèces dites nuisibles dont la liste est donnée dans chaque arrêté départemental, peuvent être détruites par le(s) détenteur(s) du droit de chasse. Généralement, la destruction à l'aide du fusil doit être autorisée par le Préfet à la demande des DRAC sollicitées par les Commandants d'aérodromes.

Enfin des battues collectives ou battues administratives peuvent être ordonnées par les Préfets de département à la demande des Commandants d'aérodromes, des Directeurs d'aéroports ou des Chefs de District.

Elles sont dirigées par les lieutenants de louveterie (conseillers techniques de l'Administration en matière de destruction d'animaux nuisibles). Elles ont pour objectif d'amoindrir la densité des populations aviaires (perdrix, faisans, pigeons, vanneaux ...) susceptibles d'entraver la circulation de la navigation aérienne.

IV.1.3. - Pour obtenir une autorisation permanente de tirs d'oiseaux dangereux pour la sécurité de la navigation aérienne, quelque soit l'espèce aviaire, le Commandant d'aérodrome doit aviser la Direction Régionale qui en fera la demande à la Préfecture. Un article spécial doit figurer à cet effet dans l'arrêté Préfectoral relatif aux Mesures de Police applicables sur l'aéroport en question.

IV. 2 - La lutte écologique

Le but de cette action est de rendre le milieu aéroportuaire inhospitalier aux oiseaux ; il s'agit donc d'une action préventive qui peut parfois résoudre le problème des oiseaux de façon définitive, c'est-à-dire en évitant la réoccupation des territoires précédemment fréquentés.

Il conviendra de faire appel aux spécialistes du problème aviaires de la Division Nuisances du STNA chaque fois que l'on estimera nécessaire d'entreprendre l'une ou l'autre des actions suivantes :

IV. 2. 1 - Suppression du couvert

Les arbres, arbustes et buissons qui servent de reposoir, d'abris ou de zone de reproduction pour certaines espèces d'oiseaux (corbeautières par exemple) doivent être supprimés ou éloignés.

IV. 2. 2 - Suppression des points d'eau

Les mares temporaires ou permanentes, les fossés de drainage, les bassins de retenu ou toute autre zone humide situés sur les aérodromes doivent être soit asséchés, soit recouverts de lignes de fils de fer galvanisé espacées d'un mètre environ, et placées à 10 centimètres au dessus de la surface.

IV. 2. 3 - Suppression des sources de nourriture

IV. 2. 3. 1 - Dépôts d'ordures :

Une action doit être entreprise en vue de supprimer ou de placer les décharges publiques situées à proximité des aérodromes (notamment dans les trouées), conformément à la circulaire du Ministre de l'Intérieur aux Préfets n°68-313 du 28 juin 1968,

.../...

et à la circulaire conjointe DBA/DNA AC n°7 du 7 novembre 1968 (Voir annexes V et V bis).

IV. 2. 3. 2. Cultures situées dans l'enceinte cloturée des aéroports

- Lors de l'attribution ou du renouvellement des contrats de locations aux agriculteurs amodiataires (Voir circulaire AC Série S. P. I. n°212 DBA du 10 novembre 1950), il conviendra d'interdire certains types de cultures particulièrement attractifs pour les oiseaux (cf. annexes VI et VII).

- En ce qui concerne les pratiques culturales, on conseillera :
  - les labours nocturnes (ils permettent aux invertébrés de s'enfouir avant le lever du jour).
  - les labours échelonnés dans le temps (après avoir retourné les champs situés d'un côté d'une piste, attendre 24 heures avant de retourner les parcelles situées de l'autre côté).
  - les moissons précoces (dès que les céréales sont mûres afin que les grains ne tombent pas sur le sol).

IV. 2. 3. 3. Semis et entretien des parties herbeuses

- il faudrait veiller lors de la constitution des bandes en herbe et des accotements, à ne semer que des graminées et non des mélanges graminées - légumineuses tels les trèfles.

- pour ce qui concerne l'entretien des aérodromes, on se réfèrera aux textes déjà anciens, mais toujours en vigueur :
  - circulaire AC série SP II n°177 DBA du 28 mars 1949 relative au contrôle de l'exécution des contrats concernant les droits de fauchage et de pacage sur les aérodromes et à la priorité à accorder aux aéro-clubs utilisateurs lors de la passation desdits contrats ;
  - circulaire AC série SP. I 4. 226 DBA du 24 avril 1951 relative à l'amodiation du droit de fauchage sur les aérodromes;
  - circulaire AC n°298 DBA du 7 juillet 1955 relative à la destruction de la végétation nuisible des aérodromes.

- Notons enfin que l'herbe des accotements devrait être maintenue à une hauteur de 15 cm environ au lieu d'être fauchée à ras et que l'herbe coupée devrait être ramassée dans la mesure du possible.

IV. 2. 3. 4. Plantations d'arbustes d'ornement

- On se réfèrera à l'annexe VI pour éviter de planter des arbustes producteurs de baies qui attirent les oiseaux.

IV. 2. 4. - Problème de la colombophilie au voisinage des aérodromes

- Les lachers de pigeons voyageurs sont en principe interdits dans les zones de protection des établissements aéronautiques. Toutefois ces lachers peuvent être autorisés sur les aérodromes avec l'accord des autorités aéronautiques intéressées dans la mesure où ils n'entravent en rien la sécurité de la navigation aérienne (cf. textes officiels de l'annexe VIII).

- L'élevage des pigeons voyageurs et des pigeons domestiques (à des fins commerciales ou non) n'est pas encore interdit à proximité des aérodromes. Les responsables aéroportuaires concernés par ce problème devront donc intervenir à l'amiable auprès des propriétaires riverains pour faire supprimer ou déplacer ces colombiers en attendant qu'un texte officiel soit publié à cet effet.

- - - - - - - - - - -

RÉPUBLIQUE FRANÇAISE
Ministère des Transports

DIRECTION GENERALE DE L'AVIATION CIVILE
Service Technique de la Navigation Aérienne
246 rue Lecourbe - 75015 PARIS
Tel. : 828.40.20

ANNEXE 1

FICHE DE COMPTE-RENDU DE RENCONTRE D'OISEAUX

1. Exploitant ....
2. Type d'aéronef ....
3. Type de moteur ....
4. Immatriculation................................
5. Date ....
6. Heure T.U. ....
7. Aube ☐ Jour ☐ Crépuscule ☐ nuit ☐
8. Lieu .... Piste en service .....
9. Hauteur / sol (ft) ....
10. Vitesse indiquée (kts) ....
11. Phase de vol :
    - Roulage .... ☐
    - Décollage (0-200ft)....... ☐
    - Montée (>200ft) .... ☐
    - Croisière................ ☐
    - Attente.................. ☐
    - Descente .... ☐
    - Approche (1000-200ft) .... ☐
    - Atterrissage (< 200ft).... ☐
    - Inconnue .... ☐
12. Phares allumés :
    - Phares d'atterrissage.... ☐
    - Feux à éclats............ ☐
13. Conditions météorologiques
    - VMC ☐ IMC ☐
    - Nuageux : ... /8 à ... ... m
    - Pluie .... ☐
    - Neige............... ☐
    - Brouillard.......... ☐

14. Espèce d'oiseaux (1)......................

. Nombre d'oiseaux :

	1	2-10	11-100	>100
- Observés	☐	☐	☐	☐
- Percutés	☐	☐	☐	☐

15. Localisation du (des) impact (s) et dommages subis

	nuls	légers (réparable)	graves (mise H.S.)
Radome	☐	☐	☐
Verrière	☐	☐	☐
Fuselage	☐	☐	☐
Train	☐	☐	☐
Empennage	☐	☐	☐
Voilure	☐	☐	☐
Moteur n° 1	☐	☐	☐
n° 2	☐	☐	☐
n° 3	☐	☐	☐
n° 4	☐	☐	☐
Autre	...	...	...

16. Plan de vol modifié .... ☐
    - . Accélération-Arrêt .... ☐
    - . Demi-tour en vol .... ☐
    - . Déroutement .... ☐
    - . Blessés, tués (précisez) ....
17. Observations : ....
....
....
....

....

(1) Les restes d'oiseaux (sous sachets plastifiés ou collés sur cette fiche s'ils ne sont pas putrescibles), devront être obligaoirement adressés soit au STNA (Division Nuisances), soit au CRNA-SE (STNA /2N, 21 Avenue Jules Isaac - 13617 AIX-EN-PROVENCE)

Modèle STNA/2N 1979

ANNEXE 2

Marche à suivre par le personnel aéroportuaire en cas d'impact d'oiseau :

Collision se produisant à l'atterrissage ou en approche.

- Le pilote rempli lui même au bureau de piste la fiche de compte-rendu de rencontre d'oiseau.

↓

- Le personnel du bureau de piste collecte les restes d'oiseaux (plumes, duvet, bec, pattes) soit sur l'avion, soit sur la piste et les dépose dans un sachet de plastique fermé.

↓

- Le Chef du service exploitation vérifie et complète au besoin la fiche d'incident en conservant une copie.

↓

- Sont transmis dans les meilleurs délais :
  - un exemplaire de la fiche à l'I.G.A.C.E.M. Bureau Enquêtes-Accidents
  - un second exemplaire de la fiche accompagné des restes d'oiseaux, au Service Technique de la Navigation Aérienne - Division 2 N - 246, rue Lecourbe - 75732 PARIS CEDEX 15

Collision se produisant au décollage ou en montée.

- Le pilote rapporte l'incident auprès de la tour de contrôle.

↓

- La tour communique au Chef du Service exploitation les renseignements concernant la collision ; ces derniers sont reportés sur la fiche de compte-rendu d'impact d'oiseau.

↓

- Le personnel du bureau de piste recherche les restes d'oiseaux soit sur la piste, soit sur l'avion(1) et les dépose dans un sachet de plastique fermé.

↓

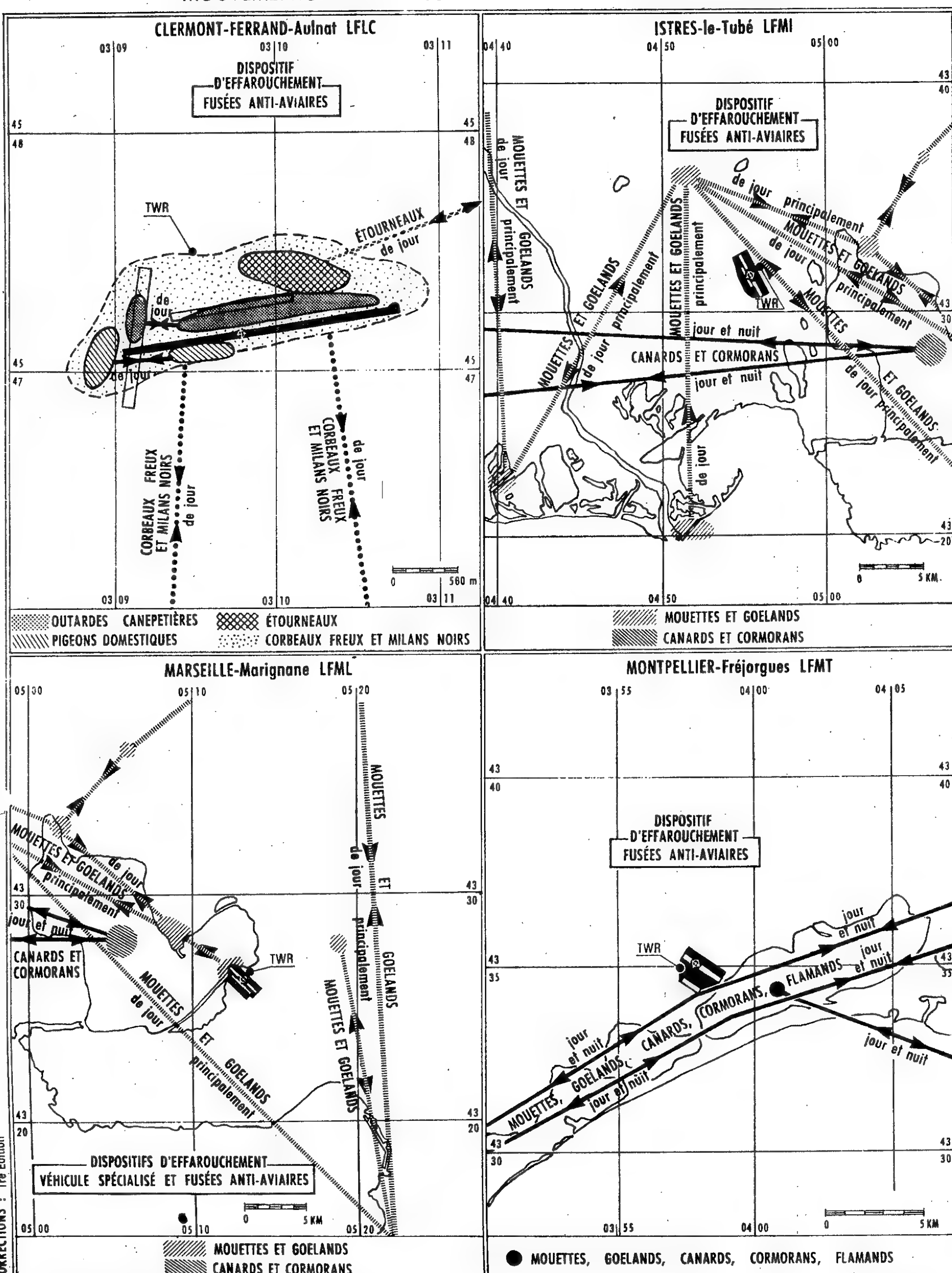
Idem ci contre.

---

(1) Dans le cas où la gravité de l'incident oblige le pilote à se poser aussitôt.

ANNEXE III

MOUVEMENTS AVIAIRES SUR ET AUX ABORDS DES AÉRODROMES



CORRECTIONS : 1re Édition

ANNEXE IV

ff lfmlzp lfmtzp lftwzp lfmpzp lfmizp lfmyzp lfmozp
230843 lfmmyo
nr229/02/e-stop-
observation radar
bird warning movement
a/aix en provence
b/observation radar vitrolles et narbonne
c/220277 0815 tu
d/especes migrateurs
e/intensité moyenne - 8 formations visibles à 50 nm est bagur
f/cap nne
g/vitesse 30 kts
h/altitude 3000 ft
i/prévision migration en cours
j/validité 4 heures.

A) Un exemple de Bird Warning Message.

jj lfzznooo
091045 lfffyn
lfff A 3156/77 du 15/2/77
fir bordeaux marseille paris
a/c 10 fev 1977 et ufn
passages diurnes et nocturnes d'oiseaux en migration :
ramiers-vanneaux-canards-grues-pluviers-grives-etourneaux-
mouettes- pose possible de ces oiseaux sur et au voisinage des
ad stop eviter survol prolonge a une hauteur inférieure a 600 m
des zones de concentration décrites par aip france rac 5-145
adresser msg de bird warning a lfmmyo pour traitement stop.

B) Un exemple de BIRTAM.

ANNEXE V

REPUBLIQUE FRANÇAISE

MINISTERE DE L'INTERIEUR

SECRETARIAT GENERAL
POUR LA POLICE

Direction de la Règlementation

- 10ème Bureau -

CIRCULAIRE - N° 68-313

PARIS, le 28 Juin 1968

LE MINISTRE DE L'INTERIEUR

à

MESSIEURS LES PREFETS

OBJET : Sécurité de la circulation aérienne - Inconvénients résultant des décharges publiques à proximité des aérodromes.-

Mon attention a été appelée par M. le Ministre des Transports sur les problèmes de sécurité aérienne posés par la présence d'oiseaux sur les pistes d'envol. Les avaries mécaniques graves qui résultent des collisions entre des oiseaux et des aéronefs peuvent avoir des conséquences irrémédiables pour ces derniers lorsque l'incident survient au décollage ou à l'atterrissage.

C'est pourquoi, depuis un certain temps déjà, des techniques ont été mises au point par les Services chargés de la circulation aérienne afin d'effaroucher les oiseaux aux abords des pistes. Toutefois cette action directe est limitée et elle doit, pour atteindre son but, être complétée par des mesures permanentes tendant à rendre ces lieux impropres au séjour habituel des oiseaux.

Or ces derniers trouvent une nourriture abondante dans les dépôts d'immondices qui ont été installés par certaines municipalités à proximité des aérodromes. Ils sont donc attirés en grand nombre en ces lieux, contribuant ainsi à rendre plus difficile l'application des mesures prises pour assurer la sécurité des aéronefs aux décollages ou aux atterrissages.

C'est pourquoi je vous demande de bien vouloir entreprendre auprès des Maires des communes intéressées de votre département une action d'information en attirant leur attention sur les dangers qui peuvent résulter de ces décharges publiques créées, sans discernement, à proximité des aérodromes ouverts à la circulation aérienne et de leur demander d'envisager le déplacement de ces dépôts lorsque les Autorités aéronautiques le jugeront nécessaire.

Pour LE MINISTRE DE L'INTERIEUR
et par délégation,

Le Secrétaire Général pour la Police :

Jacques AUBERT

ANNEXE V bis

Circulaire AC n°7 DBA du 7 novembre 1968

OBJET : - Mesures à prendre pour éviter la fréquentation des aérodromes par des bandes d'oiseaux.

La présence d'oiseaux s'envolant d'un aérodrome devant un aéronef en cours de décollage ou d'atterrissage constitue un réel danger. Des incidents nombreux se sont déjà produits à ce sujet et ont incité les Etats à rechercher les moyens d'éliminer ces risques, soit en immunisant les aéronefs, soit en rendant les aérodromes inhabitables aux oiseaux.

En France, le Service Technique de la Navigation Aérienne, qui est chargé des études relatives à cette question, a établi une notice sur l'effarouchement des oiseaux.

La méthode opérationnelle préconisée est particulièrement destinée aux Commandants d'Aérodrome qui ont la charge de mettre en oeuvre les moyens d'effarouchement.

Par contre j'attire votre attention sur le fait que les Services des Bases Aériennes doivent apporter leur concours dans la lutte contre la présence des volatiles notamment lors de l'étude des projets.

A ce sujet, il y a lieu de noter, que les expériences effectuées par les biologistes montrent que la raison principale pour toutes espèces d'oiseaux du choix d'une zone de stationnement particulière, est la possibilité de s'alimenter et que la disparition de toutes les sources principales d'alimentation et de boisson produit toujours une diminution très sensible du nombre des oiseaux.

Dans ces conditions, lors de l'étude de projets de piste, on évitera d'implanter ces ouvrages à proximité des sources d'alimentation constituées par les mares ou marais, des étangs, des dépôts d'ordures ménagères comportant notamment des débris de cuisine et des évacuations d'égouts. Si un tel voisinage ne peut être évité, il sera nécessaire d'étudier les mesures propres à réduire l'importance de la source d'alimentation (traitement des ordures ménagères - éloignement des égouts etc.).

Sur les aérodromes existants et à leurs abords il importe aussi de rechercher les moyens d'éviter les rassemblements de volatiles et de rechercher, au besoin, auprès des autorités responsables, l'éloignement des éléments pouvant servir à la nourriture notamment des dépôts d'ordures et des évacuations d'égouts.

Je vous serais obligé de toutes les mesures que vous pourrez prendre à ce sujet.

Pour le Ministre des Transports
et par délégation
Le Directeur des Bases Aériennes

J. [illegible]

ANNEXE VI

Principales cultures et plantes décoratives très déconseillées sur les aérodromes.

I - Cultures

- blé et orge d'hiver (surtout quand ces céréales sont versées)
- maïs
- trèfles, luzerne, lupin, vesces
- petits pois, choux, moutarde, fève, féverolle, salades
- engrais vert, radis fourrager, moha
- millet, tournesol, sorgho, sarrasin
- prés, pelouses contenant des trèfles

II - Plantes ornementales

- les épines-vinettes (berberis de toutes espèces)
- les mahonia (mahonia aquifolium etc. . .)
- les vignes sauvages (vitis, ampelopsis etc. . .)
- le houx (ilex acquifolium)
- les rosacées à baies ou fruits de façon générale notamment :

≠ les ronces et framboisiers (rubus de toutes espèces)	
≠ les merisiers	(prunus avium)
≠ les pruniers	(prunus divers)
≠ le prunelier	(prunus spinosa)
≠ les sorbiers	(sorbus avium et autres)
≠ les alisiers	(aria terminalis et autres)
≠ les aubépines	(crataegus oxycantha, cococcinea etc. . .)
≠ les pyracantha	(cratelgus pyracantha divers)
≠ le laurier cerise	(cerasus lauro-cerasus)
≠ les cotoneasters	(cotoneaster angustifolia, C. vulgaris pannosa etc. .)
≠ les lierres	(hedera helix etc. .)
≠ les sureaux	(sambucus nigra etc. .)
≠ les arbousiers	(arbutus unedo A et C)
≠ l'if	(taxus baccata)
≠ les génévriers	(juniperus communis etc. . .)

Il convient de supprimer le gui (viscum album) sur les arbres parasités

ANNEXE VII

Principales cultures non ou faiblement attractives pour les loiseaux, conseillées sur les aérodromes métropolitains.

Cultures non attractives (fortement recommandées) :

- la plupart des cultures sarclées, c'est-à-dire :
  - betterave fourragère ou sucrière
  - pommes de terre, carottes de plein champ, raves...
- les cultures maraichères :
  - céleri, tomates, navet, poireau, haricots, radis, asperges, persil, oignons
- le lin , le soja
- les cultures florales et l'horticulture (sauf les espèces mentionnées dans l'annexe VI.)
- Prés et pelouses composés de graminées uniquement.

Cultures moyennement attractives.

- Blé de printemps, orge de printemps (escourgeon) en traitant les semences à l'antrakinone et en choisissant les variétés naines.
- Colza

ANNEXE VIII

(1) Extrait du décret n°58.468 du 22 avril 1958 portant règlement d'administration publique pour l'application de la loi n°57.724 du 27 juin 1957 règlementant la colombophilie civile.

Article 12

Les lâchers de pigeons voyageurs sont interdits sauf dérogation spéciale prise en accord avec l'autorité militaire, dans toute l'étendue des places fortes militaires ou maritimes, des aérodromes militaires ou mixtes et dans les zones de protection des établissements militaires, maritimes ou aéronautiques.

Les autorités administratives civiles et militaires peuvent à tout moment interdire les vols d'entraînement ainsi que les lâchers de pigeons voyageurs français ou étrangers.

(2) Extrait de l'instruction générale du 18 novembre 1968 règlementant la colombophilie civile.

Section III ter

Nota. Les lâchers de pigeons voyageurs étrangers transportés par voie maritime ou aérienne ne pourront être effectués sur les aérodromes ou dans les ports qu'avec l'accord des autorités portuaires ou aéronautiques intéressées, et sous réserve que le port ou l'aérodrome d'arrivée comporte un bureau de douane de plein exercice et fasse partie ou ait la dénomination d'une des localités autorisées figurant sur la liste annexée à la présente instruction.

WP 24.

BIRD STRIKE COMMITTEE EUROPE

The Hague, October 1979

TESTS OF A DEVICE FOR THE PROTECTION OF AIRCRAFT GAS TURBINE ENGINES AGAINST BIRD STRIKES

BY MICHAEL S. WOODING
BRITISH AEROSPACE
(WARTON DIVISION)
ENGLAND

INTRODUCTION

Damage to engines from collision with birds is a problem to which a solution has yet to be found, although for the last 30 years efforts have been made in this direction with no sign of success. Bird impact on the rotating first axial compressor stages has resulted in deformation of individual blades leading to shedding of metal debris and severe damage to the entire compressor assembly.

Steps to prevent these occurrences have included strengthening of the engine itself and redesigning the compressor first stage blades to have adequate strength and stiffness and thus to avoid structural failure. However this runs counter to modern compressor design trends where the blade sections are tending towards a lower t/c ratio and a more flexible component.

Many proposals have been advanced that would prevent the bird carcase from reaching the engine whole, and some of these are shown on Fig. 1. In general these schemes were intended to slice up the bird, dispersing the individual pieces of debris and thus reducing the impact load on individual compressor blades. Whether this dispersion would occur is open to doubt, and testing that has been done has shown that the sliced

ADF 616102

portions of the carcase do not disperse but travel on a substantially undisturbed course. Furthermore, the presence of slicing grids across the intake carry with them aerodynamic penalties which significantly reduce the efficiency of the intake. More serious still are the dangers of fatigue failure of the grid structure itself and the possibility of ice accretion.

THE DEVICE

The device to be described in this paper has been devised by British Aerospace (Warton Division) and depends on the principle of attenuating and spreading the bird carcase so that the debris can be safely ingested by the engine whilst minimising the performance, structural and icing problems. It consists of placing over an appropriate area of the intake duct a suitably shaped surface located so that bird impact on, or passing across it is likely.

Initial ground tests have been completed in which birds have been fired against a variety of damaging surfaces. The results of these tests have been analysed by Rolls Royce Limited, with a view to estimating potential engine damage.

THE DAMAGING MECHANISM

The philosophy behind this approach has been to find a mechanism which, taking advantage of the kinetic energy of the bird will impale it to a sufficient extent to precipitate a significant degree of evisceration resulting in a break up of the carcase, decanting its body fluid, and spreading the resulting debris both in the direction of motion and laterally, (Fig. 2). Damaging surfaces of various types were designed. These ranged from an emery-cloth covered surface to surfaces made of expanded metal, a cheese grater type of arrangement, and a bed of nails cut off square and protruding a short distance above the surface of the duct.

THE TEST PROGRAMME

The test installation is shown diagrammatically in Fig. 3. Freshly killed chickens were fired from a conventional air operated gun which was trained on the specimen damager surface. The surface was set at angles of 10° and 25° to the approach vector of the bird, these angles being representative of swan-necked intakes in current military aircraft.

Beyond the damager test piece and perpendicular to the direction of the approaching bird a large plate representing the engine intake was set up whose front face consisted of a honeycombe of square tubes arranged to catch the debris. This assembly is known as the debris plotter. Three slow motion cameras (3000 frames/sec) using colour film were employed to record the tests, one viewing the bird before impact and two the passage of the debris between the damager and the debris plotter, both from the side and from above. Marker boards were positioned

in the field of view of the camers so that the velocity of the bird and the spread of the debris could be ascertained.

Chickens with a mass of $1\frac{1}{2}$ lb were fired and were chosen to be representative of the smaller gulls, pigeons, crows, curlews and mallards likely to be encountered. It was planned to achieve a velocity for the tests of about 150 knots since analyses of bird strikes in the United Kingdom for military aircraft show that some 40% of all strikes occur at speeds at or below that figure and these have been found to inflict particularly severe engine damage.

Rolls Royce cooperated with British Aerospace by carrying out the test analysis which was accomplished with the aid of a mathematical model that has been developed for the purpose. The analytical data required for this is based on the time history of the mass distribution of the debris arriving at the engine face. After each bird firing the debris was recovered from the plotter cells and masses and distribution recorded.

The damager types were as shown on Fig 4: A plain aluminium plate was used as a control case.

i) A rough emergy cloth

ii) A course expanded metal grid

iii) A fine expanded metal surface

iv) $\frac{1}{8}$" dia nails set at a pitch of $\frac{3}{4}$". Two variants of this were tested and were cropped off square at heights of $\frac{1}{8}$", and $\frac{1}{2}$" above the face of the base plate, which represented the surface of the intake duct.

v) A perforated metal sheet having scoop shaped protrusions similar to a domestic cheese grater.

vi) A section of steel tread plate frequently found in engineering factories, power stations etc.

By reference to the slow motion films it was possible to observe the attenuation of debris caused by various damager types and to identify the timewise distribution of discrete masses entering the debris plotter. From these films and with reference to the debris plot individual masses were assigned to these pieces of debris and their velocities calculated. It was also possible to assign a spatial impact position for those pieces of debris which had rebounded from the plotter and whose masses had been recorded subsequent to the test firing. In some instances the debris had been retarded by the damager to such an extent that it fell short of the plotter, and where this was the case it was neglected during the subsequent analysis.

In rationalising the results of the firings it was necessary to superimpose the sectional dimensions of the engine face upon the debris plot. This was because of the absence of an intake duct resulting in some debris impacting the plotter outside the theoretical periphery of the engine face. It was assumed therefore that the debris would in fact strike the tips of the compressor blades and the mass distribution recorded was adjusted to allow it to lie within the intake shape.

The adjusted debris plots for the plain aluminium sheet, perforated sheet metal, and $\frac{1}{2}$" proud nails are shown in Fig 5 and 6, where each square represents a 2" square cell of the plotter, within which the mass of the debris in ounces is noted. The engine face is represented by the curved line.

THE ANALYSIS

In considering the effects on the engine of these results the following important factors have to be borne in mind:-

i) The average slice mass (m). This can be determined from the number of blades struck by a particular mass. As the bird velocity is reduced the slice mass also decreases.

ii) The component of bird/blade relative velocity normal to the blade surface ($\bar{V}$). As the bird velocity decreases this component increases.

iii) The radial spread of debris across the engine face, found by determining the centre of mass of impacting debris (h) measured from the compressor blade root. As the individual masses impact nearer the blade roots, so the angular momentum input and thus the stress is reduced.

The product of these three components give the angular momentum input to the blade, which is proportional to the blade stress over and above that due to the rotation of the engine. Thus by comparing angular momentum terms for each type of damager tested against a common datum a comparison of the stress generated in the impacted blades can be achieved.

A comparative datum was taken of a $1\frac{1}{2}$ lb bird impacting directly on to the engine compressor face with the velocity achieved by the test birds, approximately 180 knots. From this an "m $\bar{V}$ h" term was determined.

Bird strike incidents that have actually occurred in flight to the modern turbo-fan engine under consideration, where the type and approximate mass of the bird, the relative velocities, and damage resulting are known, have also been considered. In those cases where the bird impacted the intake prior to the engine it was considered comparable to the effect produced by striking the plain aluminium plate used as the control case in the firing tests. It

has thus been possible to calculate "m $\overline{v}$ h" terms for the damaged blades involved in these incidents and assess the percentage stress in them compared to the datum which related to a known level of damage.

Three categories of damage have been allocated:

Category 1 — Major primary and extensive secondary damage, resulting in failure of engine to continue to run.

Category 2 — This is a category between 1 and 3 for which no operating experience is currently available and is one in which the damage would be expected to be somewhat less severe than in Category 1.

Category 3 — Minimal engine damage, ranging from small nicks to tears in blades. In all cases the engine would continue to run in a satisfactory manner.

By combining the test results with those from service incidents it has been possible to assess the effectiveness of each damager type investigated, and Fig. 7 shows the average stress for all shots against a particular type of damager clearly indicating the relative merits of each type.

Of the 8 types tested, 7 fell within 28% to 50% of the datum stress implying moderate damage, and the possibility that the engine would fail. However the damager consisting of ½" high rails, produced stresses at the category 3 level implying only minor damage and continued operating capability.

CONCLUSIONS

It is seen that a successful damager is one which breaks up the bird and attenuates the debris in an axial direction. Fig. 8 shows diagrammatically the effect the damagers have in dispersing the bird debris. Several of the damagers tested are likely to reduce engine damage, whilst one showed a significant reduction in blade impact stress level estimated to allow the engine to continue to operate satisfactorily. It is concluded on this evidence that a 1½ lb bird might safely be ingested at 180 knots by the engine under consideration when protection devices of the foregoing type are fitted. It is recommended that further firing tests might be contemplated to cover other test conditions and perhaps some ad hoc installations. Test firings against real engines would also add confidence to the analyses.

In conclusion I would like to thank British Aerospace for permission to present this paper, and to thank my colleagues for their help in preparing it.

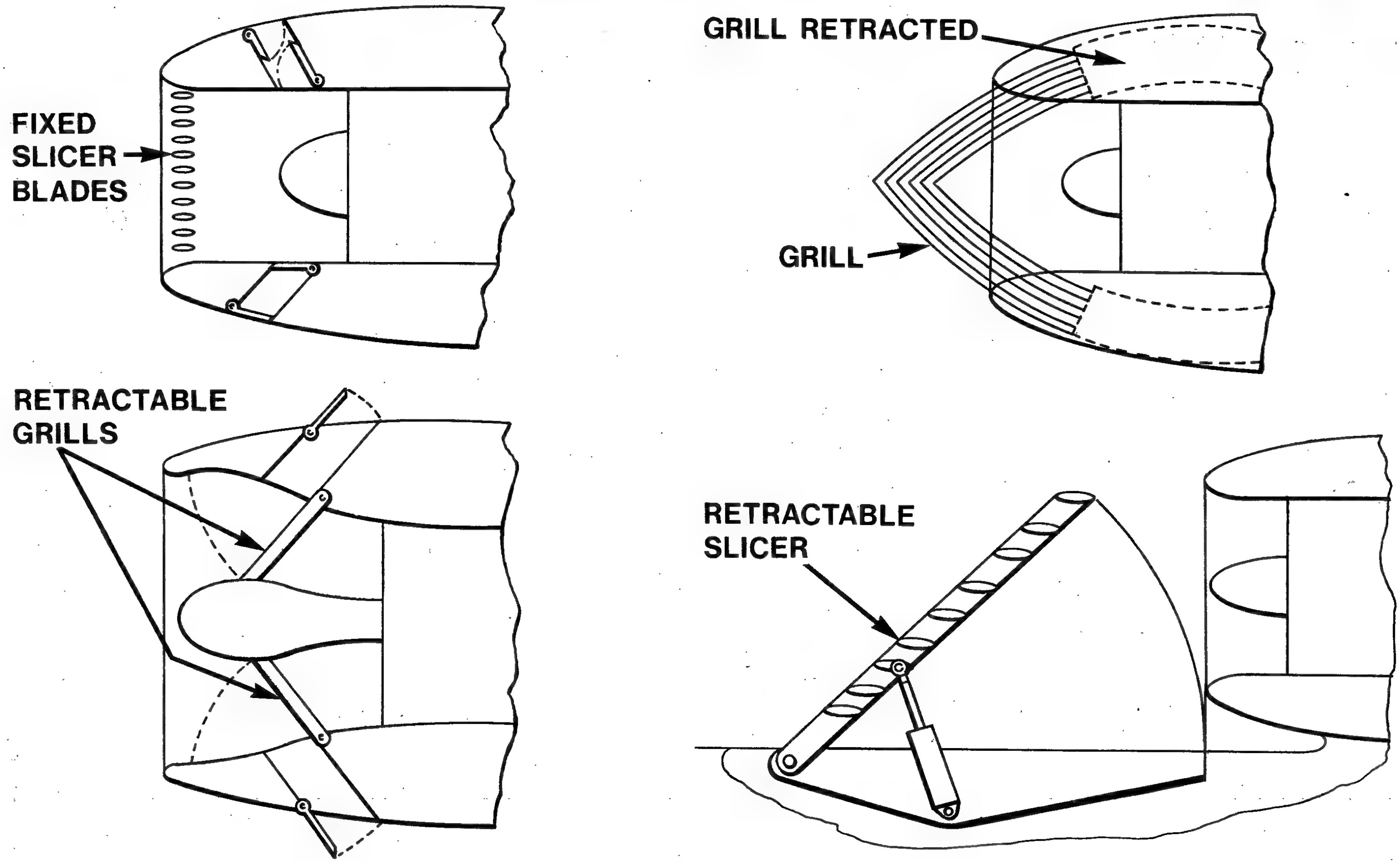


Fig. 1 Some Other Proposals for Protecting Engines

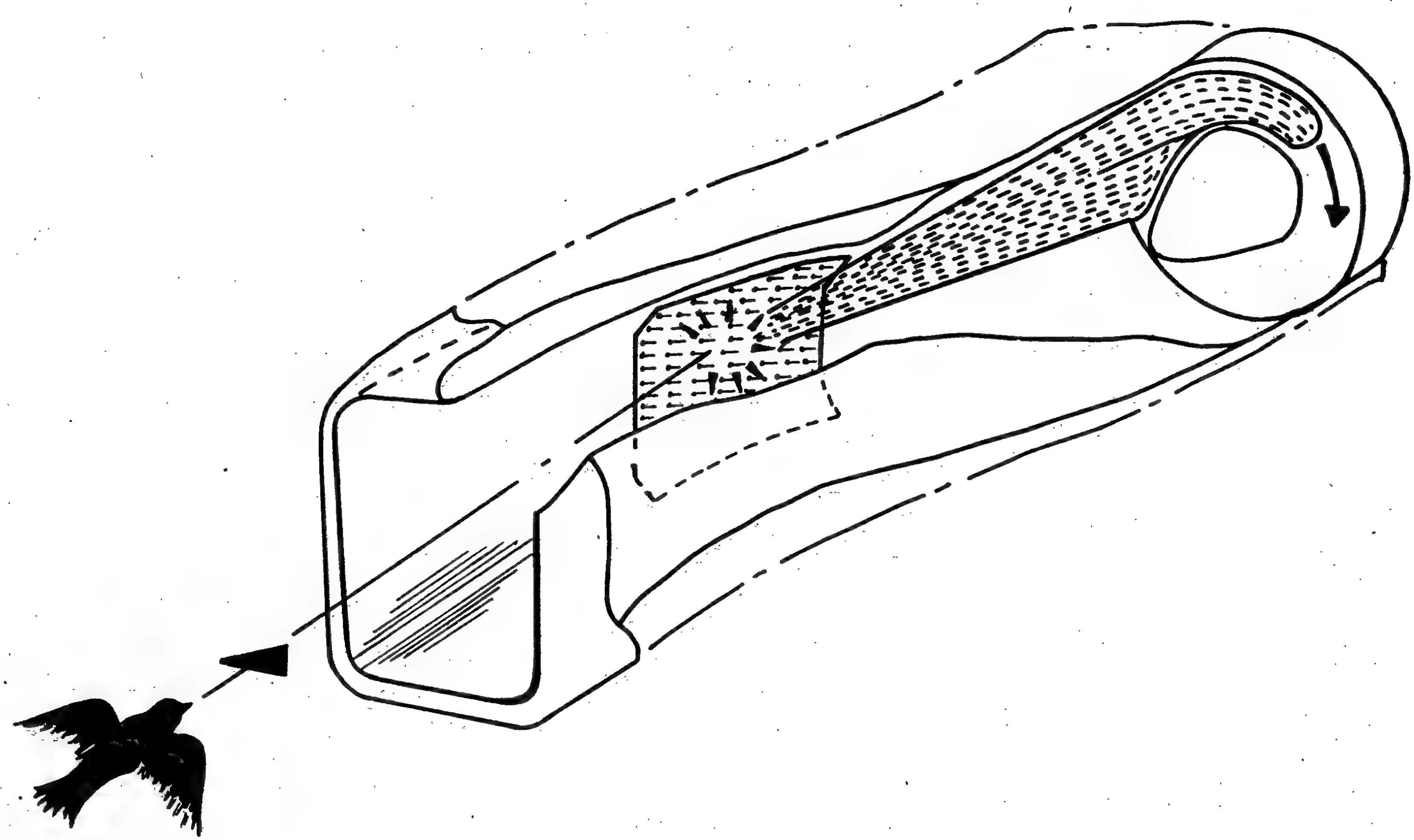


Fig. 2 Illustration of Bird Damager

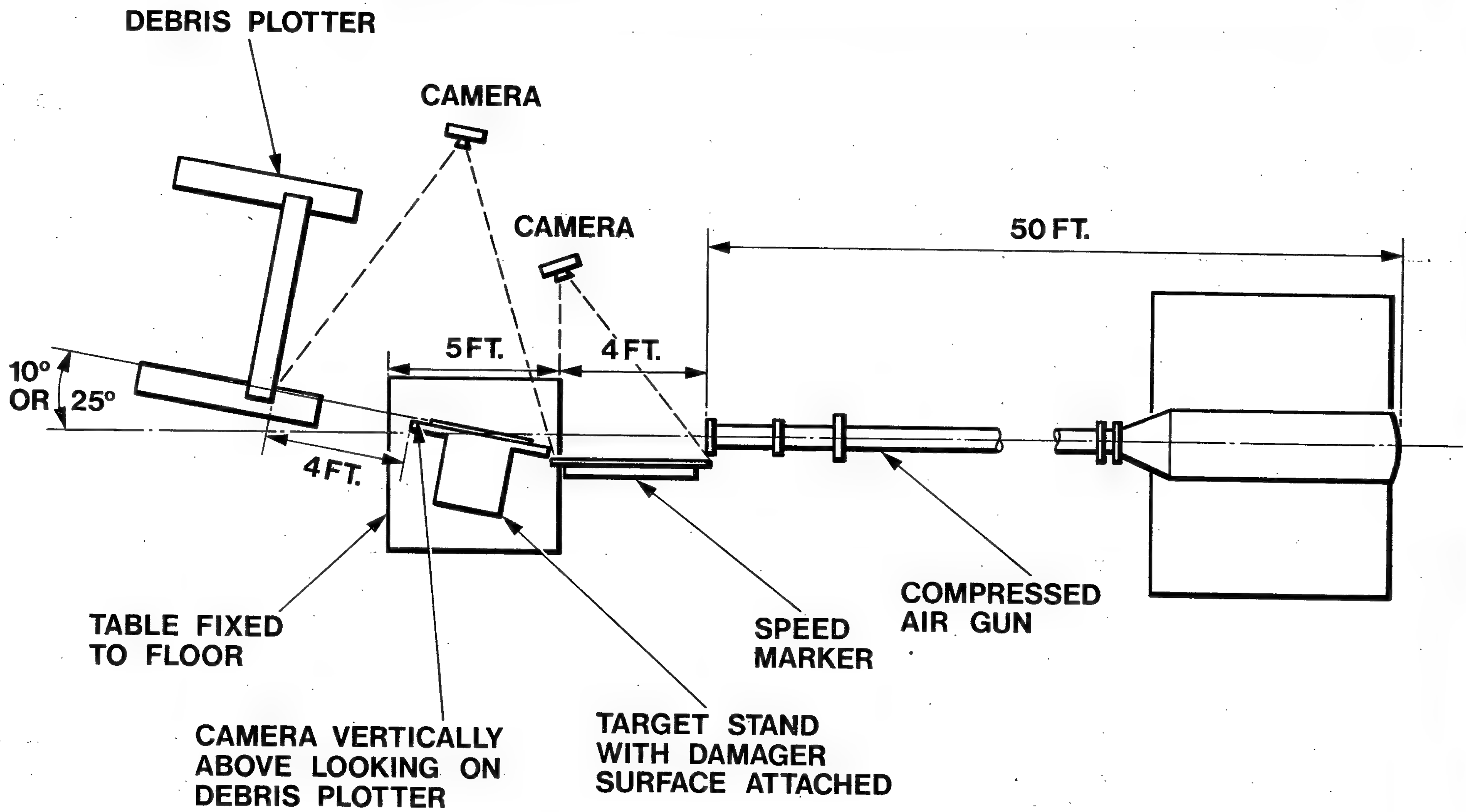


Fig. 3 Diagrammatic Test Installation Arrangement

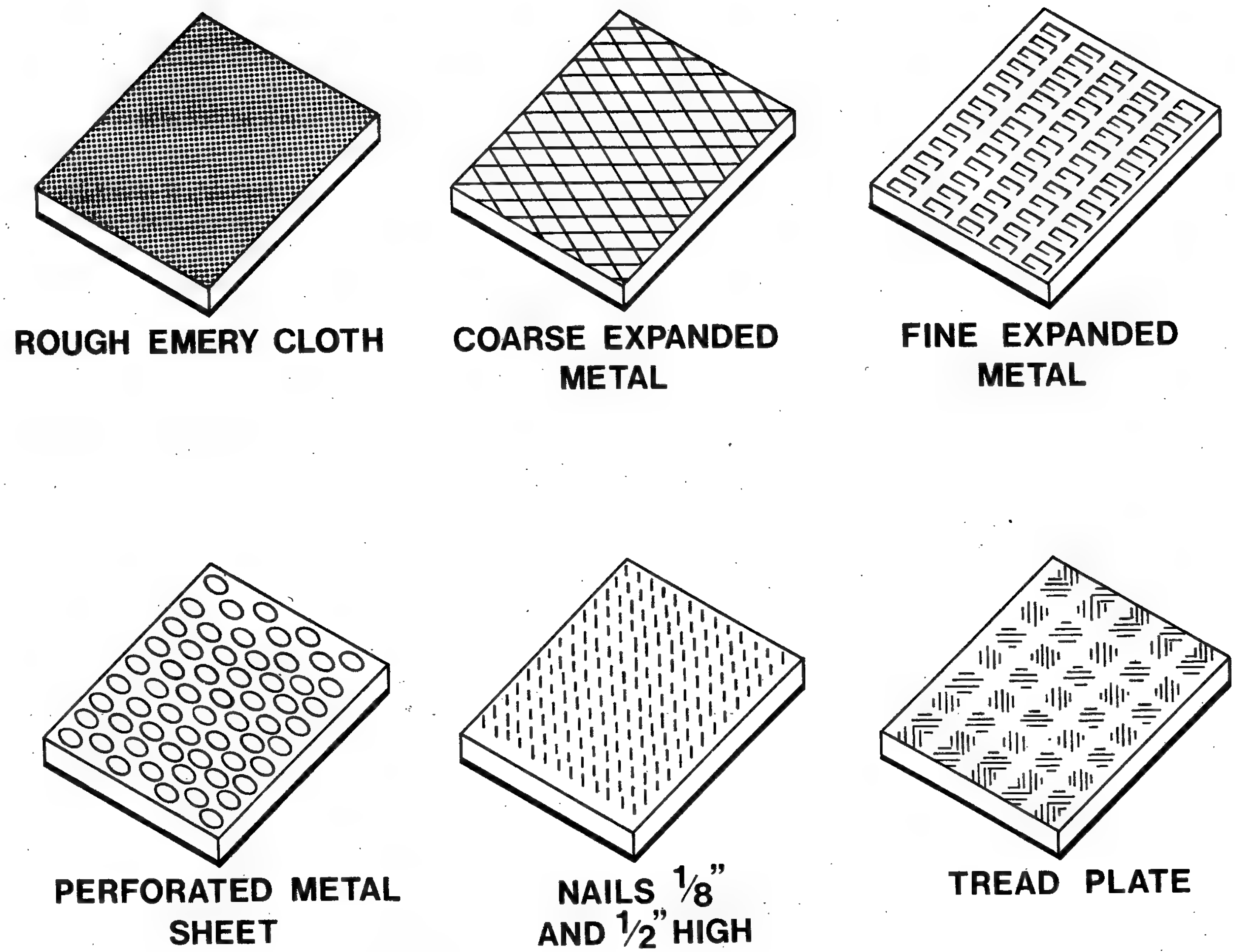


Fig. 4 Damager Surfaces Tested

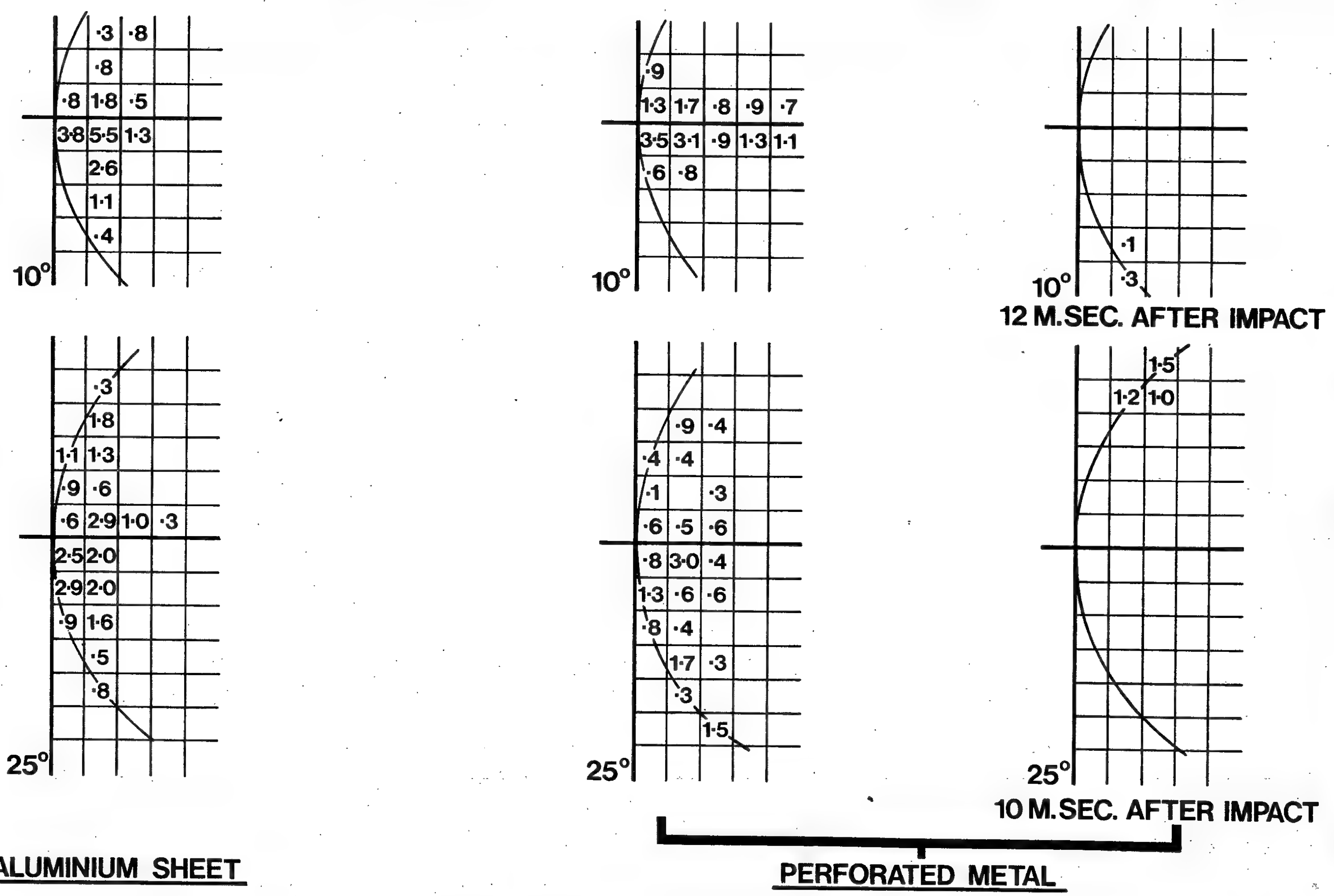
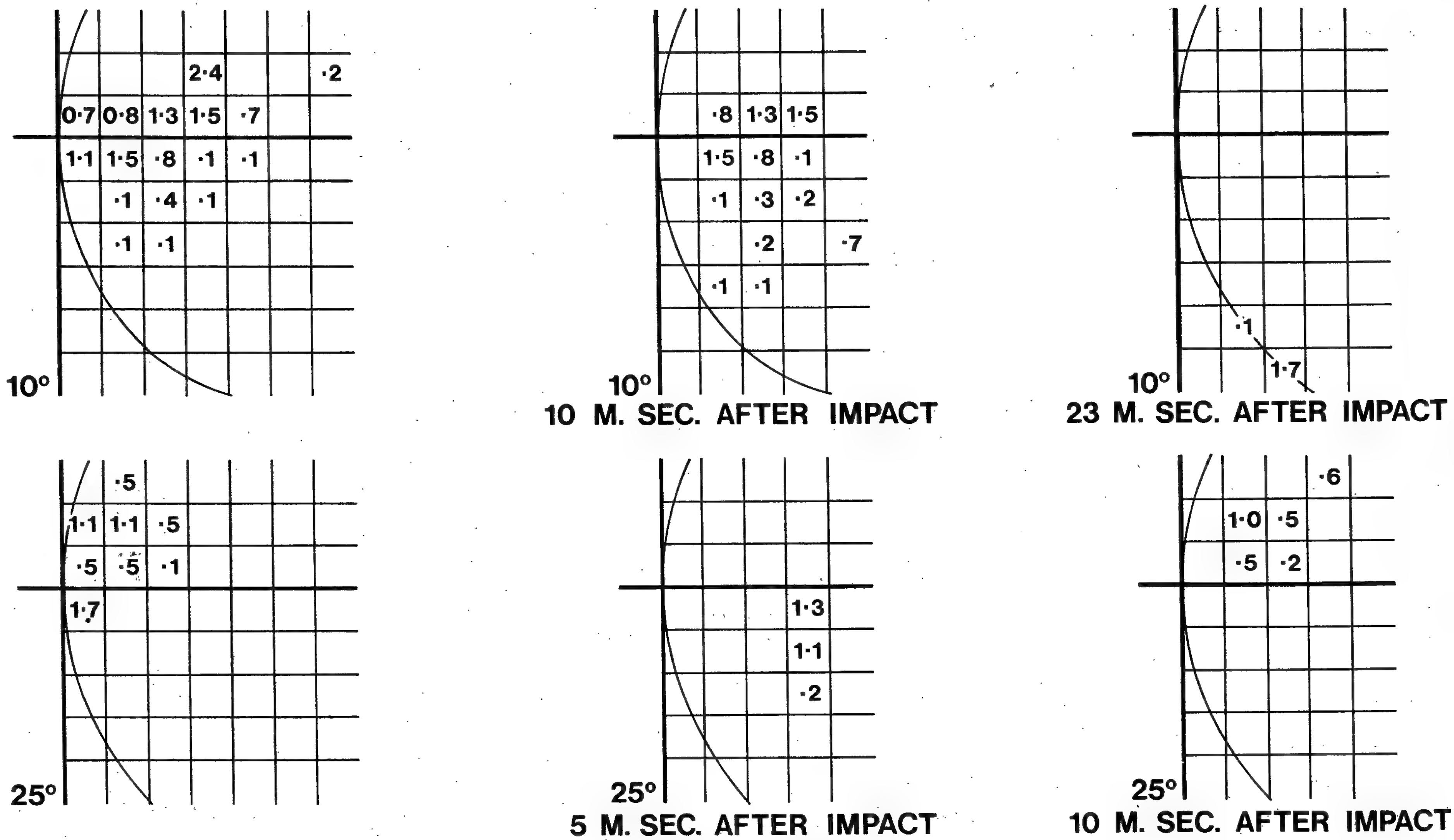


Fig. 5 Adjusted Debris Plot



1/8" NAILS x 1/2" HIGH

Fig. 6 Adjusted Debris Plot

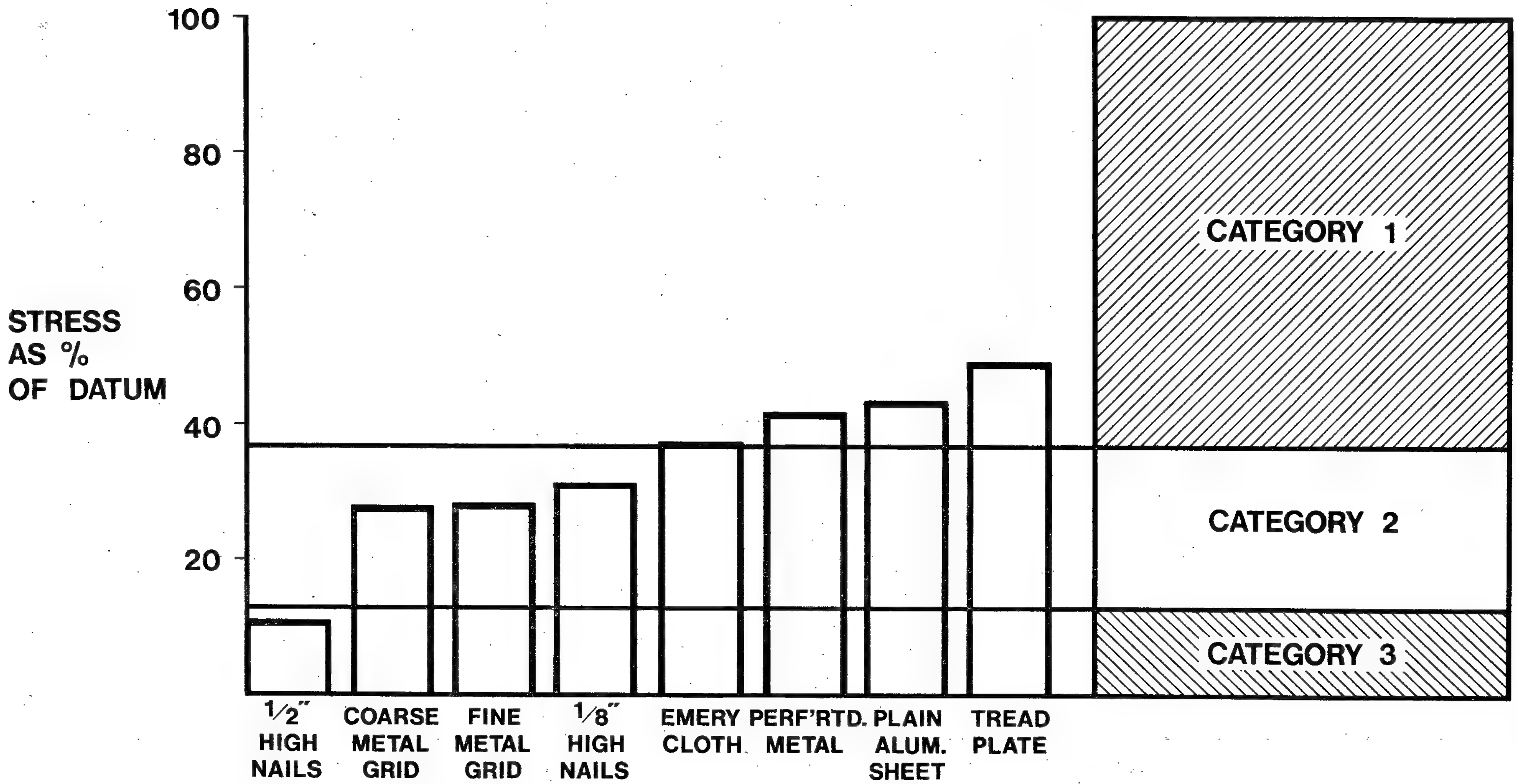


Fig. 7 Calculated Average Stress for Various Damager Surfaces

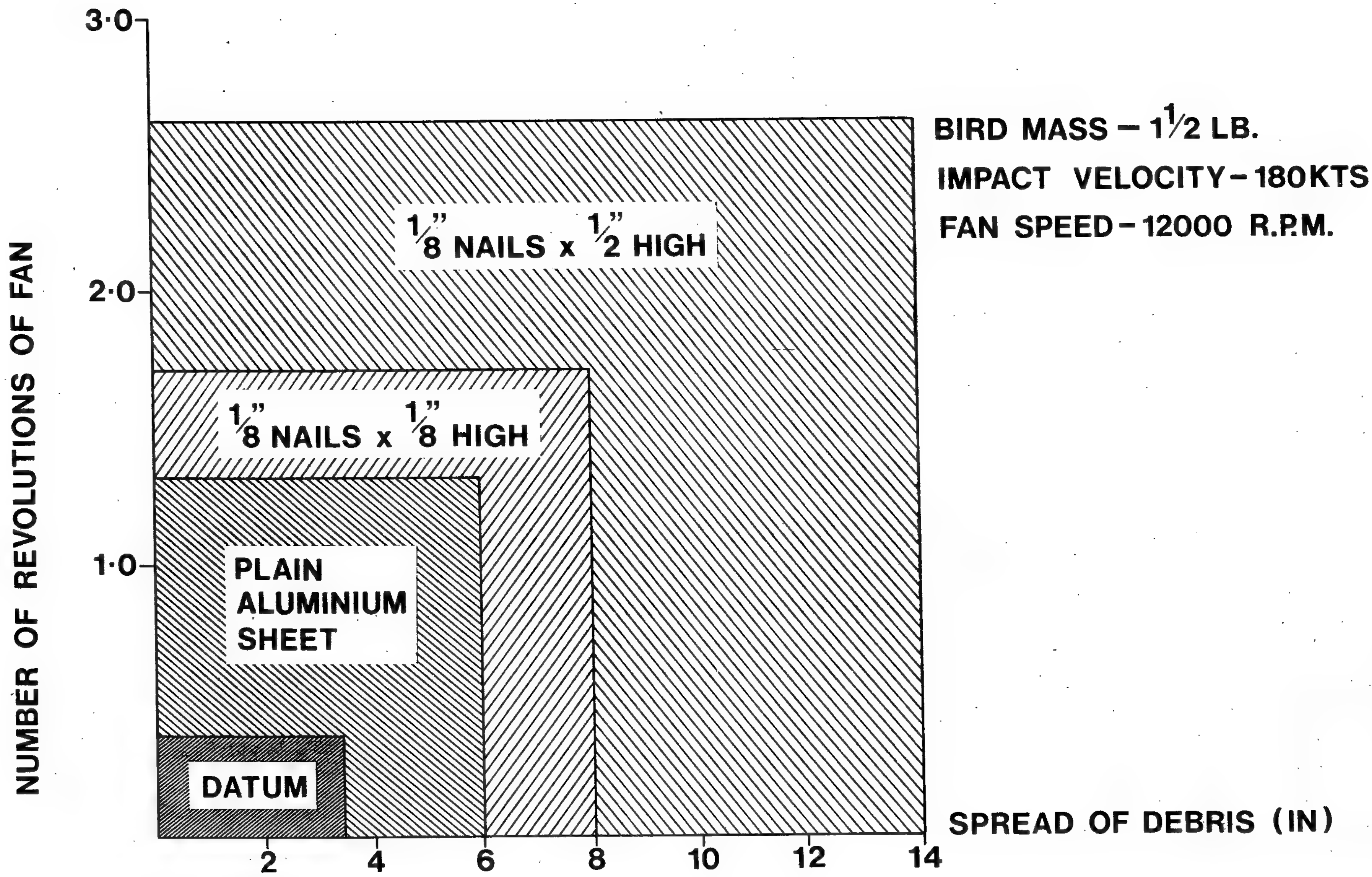


Fig. 8 Dispersal of Debris for Various Damager Types

AD F616103

Is it necessary to destroy birds on aerodromes?
by V.E. Jacoby

A.N.Severtzov Institute of Evolutionary Animal Morphology and Ecology. Academy of Sciences of the USSR. Moscow, USSR.

The problems of birds destruction on aerodromes appears usually after each serious bird strike. Some aerodrome specialists consider the bird destruction on aerodromes to be the fastest and most effective way of bird strikes prevention. Hundreds, thousands and even hundred thousands birds are known to be destroyed with the help of shooting, trapping, chemical substances in the area of aerodromes. But as far as I know - there is no reliable information about the reduction of birds number as a result of such destruction or trapping ended by longterm decrease of birdstrikes.

Destruction of 500 000 of 6 millions black birds (mostly starlings and cowbirds) with the help of chemical substances at winter night rests in the area of 2 airbases in USA didn't give any noticeable decrease of population of starlings - the basic bird dangerous for planes(ICBP, 1975). 340 million black birds are registered in USA on 100 biggest night rests only. Therefore the withdrawal of 0,5 million of birds from all population at country scall has rendered minimal effect to it. The destruction of 20.000 albatroses on US Airbase Midway didn't bring any reduction of birdstrikes number. Comparatively large number of black crows are trapped with the help of big cages at several BRD aerogromes (at Frankfurt/ Main airport up to 1000 in the year).But we have no proper information showing that this measure decreases the number of crows collisions with planes though the young birds who are most dangerous for planes according to our data (Jacoby, 1974) are being trapped in the first turn.

In my opinion the decrease of gulls (Larus argentatus) reproduction at colony near Copengagen airport as a result of chemical destruction of embryos in eggs, as well as pigeons sterilization can possibly decrease the birdstrikes peak in time of young birds appearance on aerodromes. Unselective shooting, trapping or destruction by chemical substances doesn't liquidate favourable factors attracting birds to this place (food, nesting, nightrest,

recreation). Therefore created vacuum is fulled quickly. Even complete destruction of any limited gulls colony doesn't guarantee the colonization of this place on next year by birds from neighbouring colonies. An analysis of birdstrikes and examination of bird's behaviour in the sight of a plane shows that adult local nesting or settled birds on aerodrome know the danger coming from a plane and don't fly across runway when taking off and landing of planes takes place. At present time such experienced birds are not repelled on the number of aerodromes even if the birds look for food nearby runway. This relates in the first turn to local settled crows and to rooks nesting on aerodrome or nearby. The shooting or destruction of these birds by other methods is senseless, because they are not dangerous for planes. The shooting of part of these birds will end by the fact that survived birds will be afraid of a man with gun but not of a plane on aerodrome - what is more important. The plane on aerodrome becomes the powerfull repellent mean for local birds. Therefore under intense traffic and frequent landings and taking off - there are practically no birdstrikes. They are noted in cases of long disruptions in flights; early in the morning in time of the first take-off or first landing after night disruption. In other time of day - also after disruptions in flights and in darkness which makes difficult for birds to disclose plane and to fly-off in time.

The bird's learning of plane danger takes place in three situations: directly - birds see other birds knocked down by plane or birds are thrown away of plane by airwave and indirectly - unexperienced bird follows the experienced one which takes-off timely in a sight of a plane. When we destroy the experienced birds we reduce the possibility of indirect learning of other birds and increase the possibility of the arrival of unexperienced birds at their place and thereby the probability of birdstrikes.

I venture to show you one example of shooting of home-pigeons which used to fly to airport Kherson for several klm from city in the second half of summer. Owing the permission of hunting inspection sixty pigeons were shot by hunters in two days. Pigeon's arrival stopped for several days but then resumed again because the reason attracting birds to airport-ripened seed of birds buckwheat - was not eliminated. Birdstrikes resumed simul-

taneously with pigeon's arrival. This example of shooting of birds coming to airfield shows that this measure to prevent bird strikes is unsufficient. The exclusion of bird buckweat from airfield plant cover might be more effective measure in this situation.

At the same time there are small populations of home-pigeon (Columba livia) which are nesting at some Baltic airfields (Riga, Tallin). The birdstrikes with these local populations aren't noted here.

That is why there is no necessity to destroy them. Thus it is unexpediently to destroy adult local nesting birds for preventing the birdstrikes. The decrease of young birds number at airfield with the help of the destruction embryos in eggs, the sterilization, the selective shooting or catching birds from limited airfield's population must decrease the probability of bird-strikes theoretically. But it is not always possible to characterize the effectiveness of these measures in practice because populational vacuum becomes full quickly by birds from neighbour populations or by the increase of reproduction rate at the expense of repeated eggs laying and the increased eggs number in layings. Therefore the effect can be short or poore because the number of bird strikes isn't big at every airfield. I consider the shooting of young birds which are potentially dangerous for plane to be uneffective because the survived birds which saw the shooting learn to fear a man with gun or the car from which the shooting was done but not a plane. From another side the shooting of several birds in combination with recording of distress calls increases the effectiveness of their action considerably. The use of chemical substances for lessening of feed attraction of territory (herbicides, insecticides, rodenticides) or for direct scaring, exception from the grass cover of plants attracting birds; the drainage the swamps or reservoirs, elimination of dumps and other anthropogenic sources of food nearby airfields - all these measures prevent the landing of the local birds at processed places but don't prevent transit flight on low altitudes of migrating birds - the most dangerous for planes.

In such a way all measures of the creation of ecological unattractive situation prevent only the bird's take-off from runway or nearby it as well as possible birdstrike during run and

running start of planes along runway immediately before touching or after alienation. This is very important for young and migrating birds which appeared at airfield for the first time. So far as active scaring means are concerned - that is pyrotechnical and acoustical repellents - the distance of their action amounts by pyrotechnical measures (signal rocket) to 100-120 m en horizontal and up to 50 m at vertical and by acoustical repellents depending from loudspeaker's power and wind's speed and direction. Effective action zone of one loudspeaker amounts to 500 m. These means can be used not only for bird's scaring during their flight over runway line but at the plane glissade near airfield. The practice has shown that these measures are the most effective in concern of young local and migrating birds which conceive them for the first time. When such repellents are used frequently birds get accustomed to them if they are not strengthened by shooting. But the plane becomes a repellent for birds appearing many times at airfield within the area of runway and they learn to avoid the collision with planes.

Consequently scaring measures are the effectivest for birds which are the most dangerous for plane. And on the contrary - when the action of an acoustic repellents is decreasing, the local birds become undangerous for planes. In connection with there is no necessity to strengthen by shooting the action of acoustic and other repellents. There is only sharp necessity to detect and scare the young local birds during their appearance at airfield.

All this can be referred also to migrating birds. Because of their first appearance at an airfield, poor orientation towards fast flying plane, lack of knowledge how to extrapolate tremendous (comparatively to their own) speed of plane, the absence of learning that runway is the most dangerous place at airfield - the birds flying low over an aerodrome strike most frequently with plane. That is why the migrating birds are the most dangerous for plane. The shooting of these birds will not give good result because it will not learn the survived birds to avoid running plane. Besides it is impossible to kill all migrating birds flying across an airfield.

It should be noted that at the Soviet Union airfields there are no guns for shooting or scaring the birds. The shooting at airfield is also prohibited. Therefore the most popular is birdscar-

ing by signal rocket of the same type as very pistol. The shooting of birds can be carried out only after hunter inspection's permission and with invitation of local hunters for this. As far as I know, the shooting of pigeons at airfield Kherson was the only one action of this kind. The passage of firecars with working sirens along runway at several airfields is often sufficient for bird scaring on runway and nearby.

Besides, the planes scare birds by themselves in time of intense flights. If we broadcast the distress call from firecar or flight manager car or shot from rocket - the local birds will acquire quickly the conditional reflex and the very sight of these cars is becoming a repellent for them.

In the human activity there appear situations analogous to bird behaviour on aerodrome. According to statistics the schoolchildren and young in driver's experience people get most often in such conflict situation with cars. When these people acquire the experience of extrapolation of direction and speed of their own and other cars - the number of the conflict situation decreases sharply.

We can afford to show another comparison in relation to the migrating birds. The probability of conflict situations between cars and people arriving to England from the countries with right-hand traffic movement is greater than with english people. The fast learning the visitant people to the walking and passage under new consitions is the most effective method for preventing the people's collision with cars. We can't do the same with birds. That's why the timely discovering and scaring of birds with all possible means in the period of the local nesting young birds appearance at airfield and in time when birds appear for the first time at aerodrome after post nesting migration as well as the local restriction of airfield population breeding - all this without shooting and other forms of direct birds distruction - are optimal forms for preventing the birdstrikes without the destruction of birds.

B. Aver

AD F616104

KLM

Royal Dutch Airlines

INFORMATION TO PILOTS ABOUT THE DANGER OF BIRDSTRIKES

SLIDES		SLIDES
1.L NIL		1.R NIL
2.L KLM Flight support Services presents "Birdhazard to civil aircraft"	MUSIC Birds, birds, birds Birds have already been flying for 30 million years	2.R This presentation is solely meant to inform pilots of the potential danger of bird-strikes.
3.L Flocks of geese	BIRD NOISE	3.R Single tern
4.L Single egret	and after evolution the bird became	4.R great snowy egrets
5.L Prehistoric birds	one of the most beautiful sights in nature.	5.R tern with fish
6.L Old ac	Ever since flight became reality, birds have been recognized as a potential hazard to the safe operation of aircraft.	6.R Birds+ac
	In 1912 the first birdstrike was recorded, and when the speed of aircraft increased and with the coming of turbine-engined aircraft in the 1950's, a number of factors that posed new problems were suddenly introduced.	7.R Drawning
7.L SPL final Transa.+ birds	Collisions of aircraft with birds became more frequent.	
	Since 1955 there have been more than 80 known crashes of civil and military aircraft with about 140 deaths which have been attributed to birdstrikes.	8.R ONA crash

KLM

Royal Dutch Airlines

8.L TO DC-10

9.R TO 747

Nearly 80% of all birdstrikes take place either during take-off or landing and nearly all strikes on take-off and landing occur below 2500 feet.

The take-off phase is the most dangerous phase of operation. During this phase a birdstrike could lead to the most severe consequences, Because:

Firstly there is practically possibility for avoiding action.

And secondly max. T.O. power will create max. ingestion possibility.

9.L Jet engine

The left hand slide shows a jet engine from a B 747. The fan was severely damaged, followed by a titanium fire. This was all caused by a birdstrike during T.O..

The damage costs were almost one million dollars.

10.L Fan blades

10.R compr. expl. with arrows

The slide on your right also shows birdstrike damage to the fan of a B 747 engine occurring during T.O.. This resulted in an explosion in the high pressure compressor, as shown by arrows.

./3

11.R
Graph
(5 sec)

The slide shows the number of KLM birdstrikes worldwide from 1975 to 1978
As can be seen, 1977 was the worst year and the costs to KLM were $2.000.000.

11.L
Flocks of birds

The bird population of the world is estimated to contain more than 8000 different species.

Of these the Giant Canadian Goose is one of the largest

12.R
Can. Geese

The estimated world population of birds is about hundred thousand million.

For Great Britain alone there are about 120 million birds and Northern America about 6 thousand million.

Migration

13.R
North Amer.
blow up

12.L
Migration
chart Eur.

In the northern hemisphere many birds migrate in spring from their southerly wintering areas to northerly breeding areas - and return in autumn.

The routes followed by different kinds of birds are shown on these maps.

Large scale weather situations will influence bird migration.

KLM Royal Dutch Airlines

13.L Migr. chart North/South America

14.L Radar

The peak migratory seasons for most birds occur between March and Mid April for the spring season and between mid-September and November for the fall. October accounts for the highest single birdstrike month.

Migration can be observed day and night by Radar and is reported by so called BIRDTAMS. This photograph of a radar screen taken on the eastern coast of the USA, shows the night migration of appr. 2 mill. song birds. Certain birds as swans, geese, cranes and ducks are known to migrate at reasonable altitudes of 5000 feet and even up to 20.000 feet.

14.L Airport oblique

15.R Airport oblique

What can be done to reduce bird strikes?

Environmental management is one of the best answers. Airports and their immediate surroundings are very attractive to the bird population. They like to nest in shrubs and grass, forage in garbage dumps and are attracted to swamps and trees.

The environment of every airport has to be investigated and studied with regard to the local bird problem

./5

This includes the different kinds of birds involved and their particular habits.

The main objective is to reduce the attractiveness of airports for birds.

15.L Garbage dump

Garbage dumps must be removed.

16.R Grass on airport

There are special regulations for grasslands which specify the length of the grass.

17.R agriculture near runway

Different kind of birds are attracted to different lengths of grass.

16.L Grass or agriculture near airport

Regulations concerning agricultural land near airports are important, as they control the kind of crop that may be grown. Control over wastland, woods and lakes around the airport is necessary to prevent favourable conditions for birds.

17.L NIL

BIRD DISPERSAL METHODS

18.R Van with equipment

18.L Shell crackers

There are several methods for dispersing and driving off birds.

Pyrotechnic devices such as firecrackers, flares and Shell crackers.

Shell crackers, shown on the left, can be fired from a shotgun or a Very pistol.

Sometimes it is necessary to use live
ammunation to kill the occasional bird but
many birds are protected by the law.

19.L NIL — Gas Cannons — 19.R gas cannon

Several gas cannons can be placed along the live
20.L Day-glow mills — runway. Birds that are used to being hunted may
consider this noise as indicating danger and
leave the area. — 20R Model hawk

Two devices to scare birds are shown here;
21.L Model bird — The day-glow mill on the left revolves and
the model hawk waves in the wind. Dead or
models of dead birds are useful to scare other — 21R Hawk on device
birds. This device also spins in the wind, and
gives the appearance of a white hawk flapping its
wings up and down. Apparently it does not scare
this hawk.

Distress calls of birds recorded on magnetic
tapes and played back through a loudspeaker as — 22.R Car + loud speaker
seen on this bird patrolcar
22.L captured bird — are often used near runways.

BIRD DISTRESS CALL (10 secs)

23.L Cage + buzzard — Many protected birds such as buzzards, hawks and — 23R NIL
crows can be captured and removed more than 40 miles
from the airport. These, then, are some of the more — 24R AP + birds don't mix
important bird dispersal methods which can be used
by the airport authorities.

More and more operators are responding to the fact that the best deterrent to birdstrikes is awareness of the problem and the alertness to the potential danger.

24.L
AC on final +
land lights

And now, what action can pilots take?

1. Below 10.000 ft KLM pilots have to reduce speed and switch on their landing lights. The reduced speed means that impact damage from a bird strike will be less.

   25R
   AC on final -
   landing ligh

   The switching on of the landing lights is as much to let the birds see you as to let the other aircraft see you.

2. Pilots have to be alert to the fact that when a runway is suddenly changed, it may not have been checked by the birdpatrol.

25.L
Briefing item

3. Pilots are also twice a year informed by Briefing item about migrating birds. This is interesting enough for you to read it now.

(20 secs)

BIRD NOISES

26R
Birds in th
air pilots
beware!

Pilots are strongly adviced:

26.L Text

1. To report the presence of birds on the airport, and near and on the runway; this is to enable the authorities to achieve the necessary action:

2. To report to the local ATC any birdstrike or the presence of birds near the aircraft at any time. — 27R ICAO-BSRF

27.L Text — 3. To fill in an ICAO birdstrike report form. — 28R NIL

Pilots have to be aware that;

1. The presence of birds in the take-off or landing path should require the use of a different runway.
   A delay might have to be taken while the bird patrol disperse the birds.

2. Pilots have to realise the possible risk of damage when taking off from a runway, that is newly in use. — 29R Duck cockpit window

3. When birds are present the consequences must be considered.

30R bird puffin.

28.L birds terns — MUSIC

31R birds + helicopter.

29L DC-9 Oyster-catchers

32R Falcon + end

AMS/OL/BA
22-11-'79

AD F 616 105
WP 28.

The 14th Meeting of Bird Strike Committee Europe

The Hague, The Netherlands

22 to 26 October 1979

ICAO Activities Related to Bird Strikes

by

Kenneth K. Wilde, Chief, Airports Section

The following paragraphs summarize recent ICAO activities related to bird strikes.

Reporting of Bird Strikes

The ICAO bird strike system originated in 1965 when the Airworthiness Committee decided it needed more information on bird strikes to aircraft for improvement of airworthiness criteria. The information received in response to this programme has been most useful and the airworthiness criteria have been developed and included in the Airworthiness Technical Manual.

In ICAO current activity related to bird strikes on aircraft emphasis is being given to the identification of areas/locations where the risk of a bird strike is high and to the study of other factors related to the prevention of collisions between aircraft and birds. Since 1965 many States have had considerable experience with the ICAO form and a number have developed reporting forms of their own. It was, therefore, considered timely to review the need for changes to the ICAO form.

In July 1978 all ICAO Member States were requested to submit their views on the ICAO reporting form. Response to a questionnaire sent to States was unusually good. The replies received indicated a need to change nearly every question on the form. A small Advisory Group was established within ICAO with experts provided by Australia, Canada, France, the United Kingdom and the United States. This Group met in August 1979 and developed the new form shown at Attachment A which will be soon distributed to States for use.

Under the new reporting programme it is not intended to prohibit the use by States of their own national forms. The Advisory Group recognized that certain States may wish to undertake particular national studies which would require additional questions. States intending to develop such additional questions are requested to include them after the standard questions developed by ICAO so as to facilitate analysis of the international questions.

Analysis of Strike Reports

Although the reports received from States have been useful in developing airworthiness criteria, their analysis has been on a somewhat hit or miss basis. Also, since introduction of the reporting programme the number of reports submitted has continued to rise. It is now estimated that in 1980, 6 000 reports might be received. Obviously, manual analysis of so much data is not practicable and computer programmes for storage and retrieval of the data are required. ICAO is now prepared to undertake such activity.

The Advisory Group, which was formed to revise the bird strike report form, also considered the requirements for computer programmes. You will note that the report form includes to the right of each question a small number. This number is actually the last two digits of the field identification number for computer storage. The provisional master file for each bird strike report is shown at Attachment B. As can be seen, the file includes considerably more data than the questions included on the report form. Some of this information, such as aircraft characteristics, will automatically be included in the stored data when the aircraft model is entered. Other data, which might be included under remarks on the form, is to be coded so as to facilitate its extraction.

The field developed for the international questions includes 355 characteristics. Actually, the computer programme reserves a field of 500 characteristics for each report. These additional fields can be used for storage of information derived from future questions and from questions included on national forms. The Advisory Group recommended that States desiring to include additional questions on their own national forms should co-ordinate such questions internationally in order to facilitate the exchange and use of the information by other States.

At the present time it is anticipated that Australia, Canada, France and the United Kingdom are likely to develop their own computer programmes. To facilitate the storage of reports these States (and other that may develop computer programmes) will be requested to transmit their strike report data to ICAO via computer tape.

In order to stimulate reporting it is hoped to make the reporting procedure as simple as possible. For those States receiving only a few strike reports they can submit copies of the reports direct to ICAO as the State receives them. States which develop computer programmes will be requested to submit the tapes quarterly. Naturally, States will also be able to tabulate their data for sending on to ICAO and these States will be requested to use the computer code to simplify ICAO's work.

A manual is currently being written in ICAO explaining the computer programme. Copies of this manual will be distributed to States around mid-1980.

In addition to explaining the input programme the manual will also explain the formats for output. At the present time five different types of output are envisaged. There are: 1) State record print; 2) serious strikes brief print; 3) world standard array; 4) State standard array; and 5) special arrays.

The State record print would be an annual print provided to each ICAO State (except those which have advised ICAO they have their own computer programme). It would be a complete print-out of all data submitted on strikes occurring in that State.

The serious strikes brief print, as the name implies, would summarize serious strikes to aircraft. As it would be relatively short and the information would be of timely interest, a semi-annual print-out has been selected.

The world standard array would be an annual print which would show a general overview of the bird strikes to aircraft problem. The exact form of the array is still being developed but basically it will compare the type of birds

struck (on the horizontal axis) with other factors such as light conditions, flight phase, parts struck (on the vertical axis).

The State standard array would be an annual print directed towards providing States with information identifying where bird strikes are occurring within their countries. Its purpose would be to permit a State to take action to reduce the strikes. The horizontal axis would be similar to that for the world standard array, the vertical axis would include information related to the conditions under which the strikes occurred.

The special arrays have not yet been developed but these will be used for analysis of particular problems such as strikes to aircraft engines. Actually, the ICAO programme is being developed so that any State can request ICAO for any particular analysis which it may be interested in.

The present schedule is for the computer programmes to become operational around mid-1980. This should permit the first serious strikes brief print to be published before the end of 1980 and the first world and States' standard arrays for the 1980 strike data.

Bird Control on Aerodromes

At your 13th meeting a report was submitted on the ICAO workshop on bird hazards to aircraft held in Bangkok, Thailand. The results of this workshop were encouraging and ICAO has investigated the usefulness of convening similar workshops in other parts of the world. The present intent is to hold one such workshop annually in a different region. Planning is now going ahead for a meeting of African States south of the Sahara which will be held in the ICAO Regional Office in Dakar during the week of 10 March 1980. BSCE States which assisted ICAO in the Bangkok workshop are again being requested to support the Dakar workshop.

As a follow-up to the Bangkok workshop, the ICAO Regional Office in Bangkok is investigating the interest of States to hold a second workshop for the Asia/Pacific area. No plans have yet been laid for this meeting, but a meeting near the end of 1980 is being considered.

Airport Services Manual

Guidance material for use by States in combating the bird hazard problem is published by ICAO in the Airport Services Manual, Part 3 entitled "Bird Control and Reduction". Thanks to comments from BSCE, the old ICAO manual was revised and a new edition published in 1978. ICAO has a programme for updating its manuals and it looks forward to further contributions by BSCE for improving this manual. As a result of the new bird strike reporting system and computer programme, it is anticipated that an amendment to the manual will be published during 1980 or '81.

Audio Visual Aids

The ICAO approach to combating the bird hazard programme has been that much is already known to reduce bird strikes but more needs to be done to implement what is known (thus the ICAO workshops). In support of this approach ICAO has under its Acquired Rights Programme reissued the Canadian film "Operation Bird Strike" including versions with French and Spanish soundtracks. It is now in the process of distributing an audio visual slide programme developed by the United States, which is aimed at publicizing the bird strike to aircraft problem. Another current project is to produce a poster for installation at airports calling attention to the need

for pilots to report bird strikes. In the near future work will be undertaken to bring up-to-date the film "Operation Bird Strike" which was made in the early '60s. Arrangements have been made with the Canadian government to undertake this work jointly.

Annex 14 Specifications

This paper has covered reporting of bird strikes, provision of guidance material to States and other matters, but it has said nothing about development of international specifications for control of birds at airports. Annex 14, which contains international Standards and Recommended Practices for aerodromes contains only the following single specification related to birds:

> "9.5.1 Recommendation.- The appropriate authority should take action as necessary to decrease the number of birds constituting a hazard to aircraft operations by adopting measures for discouraging their presence on or in the vicinity of an aerodrome."

This single specification was included in Annex 14 in 1969 as a result of discussions at the Fifth Air Navigation Conference. Since that time ICAO has not been able to develop one single additional specification that would assist in reducing the probability of a bird strike at an airport. What can be done? Certainly after ten years of experience it should be possible to develop more definitive specifications as to what measures should be taken, what equipment should be provided at an airport to reduce bird strikes. Cannot BSCE take the lead in this work? ICAO needs advice on how to expand its specifications to reduce bird strikes at airports.

- - - - - - - - - -

ATTACHMENT A

Bird Strike Reporting Form

Send to:

Operator ______________________ 01/02

Aircraft Make/Model ______________________ 03/04

Engine Make/Model ______________________ 05/06

Aircraft Registration ______________________ 07

Date day______ month______ year______ 08

Local Time ______________________ 09

dawn ☐ A day ☐ B dusk ☐ C night ☐ D 10

Aerodrome Name ______________________ 11/12

Runway Used ______________________ 13

Location if Enroute ______________________ 14

Height AGL __________ FT 15

Speed IAS __________ KT 16

Phase of Flight 17

- parked ☐ A
- taxi ☐ B
- take-off run ☐ C
- climb ☐ D
- enroute ☐ E
- descent ☐ F
- approach ☐ G
- landing roll ☐ H

Part(s) of Aircraft	Struck		Damaged
radome	☐	18	☐
windshield	☐	19	☐
nose (excluding above)	☐	20	☐
engine no.1	☐	21	☐
2	☐	22	☐
3	☐	23	☐
4	☐	24	☐
propeller	☐	25	☐
wing/rotor	☐	26	☐
fuselage	☐	27	☐
landing gear	☐	28	☐
tail	☐	29	☐
lights	☐	30	☐
other (specify)	☐	31	☐

Effect on Flight

- none ☐ 32
- aborted take-off ☐ 33
- precautionary landing ☐ 34
- engines shut down ☐ 35
- other (specify) ☐ 36

Sky Condition 37

- no cloud ☐ A
- some cloud ☐ B
- overcast ☐ C

Precipitation

- fog ☐ 38
- rain ☐ 39
- snow ☐ 40

Bird Species* ______________________ 41

Number of Birds	Seen 42	Struck 43
1	☐ A	☐
2-10	☐ B	☐
11-100	☐ C	☐
more	☐ D	☐

Size of Bird 44

- small ☐ S
- medium ☐ M
- large ☐ L

Pilot Warned of Birds 45

yes ☐ Y no ☐ N

Remarks (describe damage, injuries and other pertinent information) 46/47 ______________________

____

____

____

____

____

Reported by ______________________
(optional)

*Send bird remains to:

THIS INFORMATION IS REQUIRED FOR AVIATION SAFETY

ICAO BIRDSTRIKE INFORMATION SYSTEM - / FIELD IDENTIFIER

FIELD IDENT	FIELD NAME	CODING SPECS	START POS'N	FIELD LENGTH	REMARKS
0001	ICAO FILE NUMBER	YR + 6 DIGITS	001	08	ADREP FORMAT
0002	STATE FILE NUMBER		009	06	
0003	STATE SUBMITTING REPORT	ADREP	015	04	
0004	STATE OF OCCURRENCE	ADREP	019	04	
0005	STATE OF REGISTRY	ADREP	023	04	
0006	DATE OF LAST RECORD CHANGE	DDMMYY	027	06	AUTOMATIC
0007	'FLAG' - ERRORS	ADREP	033	01	AUTOMATIC
0008	'FLAG' - STATES DIFFERENT	Y OR BLANK	034	01	AUTOMATIC
0009	AIRCRAFT MAKE	PLAIN LANGUAGE	058	11	AUTOMATIC
0010	AIRCRAFT MODEL	PLAIN LANGUAGE	069	06	AUTOMATIC
0011	AIRCRAFT CLASSIFICATION	ADREP	075	01	AUTOMATIC
0012	AIRCRAFT WEIGHT CATEGORY	ADREP	076	01	AUTOMATIC
0013	NUMBER OF ENGINES	ADREP	077	01	AUTOMATIC
0014	TYPE OF POWER	ADREP	078	01	AUTOMATIC
0015	BIRD SCIENTIFIC NAME	PLAIN LANGUAGE	197	20	AUTOMATIC
0016	BIRD COMMON NAME	PLAIN LANGUAGE	217	20	AUTOMATIC
0017	BIRD MEAN WEIGHT	IN GRAMS	237	04	AUTOMATIC
0018	ENGINE BYPASS RATIO	V. FERRY	248	01	AUTOMATIC
0019	ENGINE - WING POD BELOW	1/2/3/4/BLANK	249	01	AUTOMATIC
0020	ENGINE - WING POD ABOVE	1/2/3/4/BLANK	250	01	AUTOMATIC
0021	ENGINE - WING ROOT	1/2/3/4/BLANK	251	01	AUTOMATIC
0022	ENGINE - WING SUSPENDED	1/2/3/4/BLANK	252	01	AUTOMATIC
0023	ENGINE - AFT FUSELAGE	1/2/3/4/BLANK	253	01	AUTOMATIC
0024	ENGINE - AFT CENTRAL	1/2/3/4/BLANK	254	01	AUTOMATIC
0025	ENGINE - NOSE CENTRAL	1/2/3/4/BLANK	255	01	AUTOMATIC
0101	OPERATOR NAME	DIRECT ENTRY	035	15	
0102	OPERATOR CODE	ICAO 8885	050	03	VERIFY LENGTH
0103	AIRCRAFT MAKE CODE	ADREP	053	03	
0104	AIRCRAFT MODEL CODE	ADREP	056	02	
0105	ENGINE MAKE CODE	ADREP	079	02	
0106	ENGINE MODEL CODE	ADREP	081	02	
0107	AIRCRAFT REGISTRATION	DIRECT ENTRY	083	08	
0108	DATE OF OCCURRENCE	DDMMYY	091	06	
0109	LOCAL TIME OF OCCURRENCE	HHMM	097	04	
0110	LIGHT CONDITIONS	A TO D	101	01	
0111	AERODROME NAME	DIRECT ENTRY	102	20	
0112	AERODROME CODE	ICAO 7910	122	04	
0113	RUNWAY USED	DIRECT ENTRY	126	03	
0114	LOCATION IF ENROUTE	DIRECT ENTRY	129	20	
0115	HEIGHT AGL (FEET)	DIRECT ENTRY	149	05	

ICAO BIRDSTRIKE INFORMATION SYSTEM - BY FIELD IDENTIFIER

FIELD IDENT	FIELD NAME	CODING SPECS	START POS'N	FIELD LENGTH	REMARKS
0116	SPEED (IAS - KNOTS)	DIRECT ENTRY	154	03	
0117	PHASE OF FLIGHT	A TO H	157	01	
0118	S/D RADOME	S OR D	158	01	
0119	S/D WINDSHIELD	S OR D	159	01	
0120	S/D NOSE (EXCLUDING ABOVE)	S OR D	160	01	
0121	S/D ENGINE 1	S OR D	161	01	
0122	S/D ENGINE 2	S OR D	162	01	
0123	S/D ENGINE 3	S OR D	163	01	
0124	S/D ENGINE 4	S OR D	164	01	
0125	S/D PROPELLER	S OR D	165	01	
0126	S/D WING/ROTOR	S OR D	166	01	
0127	S/D FUSELAGE	S OR D	167	01	
0128	S/D LANDING GEAR	S OR D	168	01	
0129	S/D TAIL	S OR D	169	01	
0130	S/D LIGHTS	S OR D	170	01	
0131	S/D OTHER PART	S OR D	171	01	
0132	EFFECT - NONE	Y OR BLANK	176	01	
0133	ABORTED TAKE-OFF	Y OR BLANK	177	01	
0134	PRECAUTIONARY LANDING	Y OR BLANK	178	01	
0135	ENGINE(S) SHUT DOWN	1/2/3/4/BLANK	179	01	
0136	EFFECT - OTHER	Y OR BLANK	180	01	
0137	SKY CONDITION	A TO C	188	01	
0138	WEATHER - FOG	Y OR BLANK	189	01	
0139	WEATHER - RAIN	Y OR BLANK	190	01	
0140	WEATHER - SNOW	Y OR BLANK	191	01	
0141	BIRD SPECIES CODE	PENDING	192	05	
0142	BIRDS SEEN	A TO D	241	01	
0143	BIRDS STRUCK	A TO D	242	01	
0144	BIRD SIZE	S/M/L	243	01	
0145	PILOT WARNED	Y OR X	244	01	
0146	REMARKS (1)	DIRECT ENTRY	401	50	
0147	REMARKS (2)	DIRECT ENTRY	451	50	
0201	AIRCRAFT DAMAGE	D/S/M/BLANK	245	01	ICAO DEF'N
0202	INJURY INDEX	F/S/M/BLANK	246	01	
0203	S/D PITOT STATIC	S OR D	172	01	
0204	S/D ANTENNA(E)	S OR D	173	01	
0205	S/D TAIL ROTOR	S OR D	174	01	
0206	S/D HELICOPTER TRANSMISSION	S OR D	175	01	
0207	FORCED LANDING	Y OR BLANK	181	01	
0208	FIRE	Y OR BLANK	182	01	

ICAO BIRDSTRIKE INFORMATION SYSTEM - BY FIELD IDENTIFIER

FIELD IDENT	FIELD NAME	CODING SPECS	START POS'N	FIELD LENGTH	REMARKS
0209	PENETRATION OF WINDSHIELD	Y OR BLANK	183	01	
0210	PENETRATION OF AIRFRAME	Y OR BLANK	184	01	
0211	VISION OBSCURED	Y OR BLANK	185	01	
0212	ENGINE INGESTION	1/2/3/4/BLANK	186	01	
0213	ENGINE UNCONTAINED FAILURE	1/2/3/4/BLANK	187	01	
0214	SPECIES CONFIRMED	Y OR BLANK	247	01	

- END -

ADF 616 106

WP 29.

AIR FRANCE
DIRECTION DES OPERATIONS AERIENNES
Sous-Direction Technique
Département Lignes & Régions

14 TH MEETING
BSCE.

BIRD RISK AND AIR SAFETY

—

13th Meeting of the
BIRD STRIKE COMMITTEE EUROPE

—

PROPOSALS OF RECOMMENDATIONS

AIR FRANCE

—

Made by Georges MARCAL
Flight Operations Superintendant AIR FRANCE
and
Member of the French Delegation
to the BSCE Meeting in BERNE

- PARIS, December 1978 -

Compagnie Nationale AIR FRANCE
Flight Operations Division

BSCE - 13 / WP 31

(31/1 - 31/2 - 31/3)

BIRD HAZARDS TO AIRCRAFT

13th Meeting of the

BIRD STRIKE COMMITTEE - EUROPE

held in BERNE from May 29 to June 2, 1978

PROPOSALS OF RECOMMENDATIONS

made by Georges MARCAL (Flight Operations Superintendent, AIR FRANCE)

a Member of the French Delegation to the BSCE Meeting in BERNE

1. ON THE URGENT NECESSITY OF SETTING UP A SYSTEM OF TAKING IMMEDIATE ACTION AT AIRPORTS

2. ON THE ADOPTION OF A CLASSIFICATION OF THE TYPES OF INCIDENTS ACCORDING TO THEIR EXTENT AND DEGREE OF SERIOUSNESS

3. ON THE ADOPTION OF A CLASSIFICATION OF AIRPORTS ACCORDING TO THEIR DEGREE OF PROGRESSIVE OR UNDISPUTED BIRD RISK

N.B. : The original text of the first proposal has been appreciably modified and that of the third proposal considerably enlarged, in conformity with the comments made at the speaker's podium of the BSCE meeting on June 1, 1978 by Georges Marcal.

At the end of Mr. Marcal's speech, the Chairman of the Aerodrome Working Group, Mr. Kurt Pedersen (Denmark), asked the Meeting Chairman, Mr. Ferry (who agreed), that adoption of the present three proposals be the subject of later discussions by the BSCE.

BIRD RISK AND AIR SAFETY

WP 31/1

/ PROPOSED RECOMMENDATION No. 1 /

1. ON THE URGENT NECESSITY OF SETTING UP A SYSTEM OF TAKING IMMEDIATE ACTION AT AIRPORTS

1.1. General Situation

Most of the time our jet aircraft fly at altitudes where birds normally are never found.

The critical zone in which aircraft and birds risk coming into contact with each other is therefore almost exclusively located at or near airports, between the ground and low or medium altitudes, and in the great majority of cases involves the flight phases of take-off and climb on the one hand and approach and landing on the other.

Given this critical zone, the airport authorities have concentrated their efforts - especially during the last few years - on studying an overall system of protection extending from the airport grounds into their surroundings.

Generally speaking, this program has had three objectives :

- discouraging birds from remaining at the airport or in its immediate surroundings ;
- driving away from flight paths birds that risk crossing them in large groups ;
- informing cockpit crews (i.e., a few moments before take-off or during approach) about any unusual, worrisome concentration of birds on the airport grounds, with a view to preventing accidents.

1.2. Research and Achivements

During the last decade many studies and experiments have been undertaken by the BSCE member States.

Moreover, the carrying out of very diversified agronomical operations at and near a large number of airports plus the installing of equipment and other means of discouraging and frightening away birds definitely show both the general realization of the risks presented by birds and the firm intention of the Administrations permanently to maintain airport safety, which they indeed have the mission of ensuring.

We have noted that means of rapid application have already been taken by the majority of European States at their airports, whatever the equipment and means used to frighten birds away, and that these are now in force.

1.3. The Weakness of the Present System : Absence of Pre-established, Coordinated Means of Taking Immediate Action

Nevertheless, despite the many studies and achievements by very experienced specialists and despite means very closely adapted to the airports involved, the number of bird strike incidents at or near airports paradoxically increases every year.

AIR FRANCE alone incurred :

- 17 bird strikes in 1976 ;

- 23 bird strikes in 1977.

And between January 1 and May 15, 1978 - that is, across only four and a half months - it already incurred 17 :

- of which 1 was a very important incident ;

- and 3 were very serious !

We cannot therefore any longer hide from ourselves the extreme seriousness of some of these incidents.

. What can be the cause of this paradox ?

. What actually takes place under real conditions ?

Of course we are well aware that the speeding up of urbanization in Europe as well as the accelerated extension of newly constructed or further developed areas for every sort of use are drastically reducing the free areas needed by and favorable to birds.

In this situation , which is more and more troublesome for birds, airport grounds represent areas that may be all the more attractive because they are near other natural areas such as seashores, lakes, swamps, rivers, forests, etc.

This is why, especially when overall or regional weather conditions are very bad, large flocks of birds suddenly take shelter on airport grounds and constitute for the latter, if the airport does not have a permanent system of active surveillance, another danger which can be more important because it is temporarily unrecognized - both by the control tower and by the cockpit crews.

We have all had an opportunity to notice that the rise in bird strike incidents recorded in the first quarter of 1978 was directly caused by the very bad weather conditions prevalent in western and southern Europe during that quarter.

Now a thorough study of the circumstances surrounding most of the incidents leads us to the realization that too often this type of risk has clearly been underestimated at airports :

./.

- occasional surveillance of bird movements on airport grounds ;
- very infrequent sufficiently quick communication of information to cockpit crews ;
- immediate action too often impossible, because of the lack of a set of pre-established, coordinated orders ;
- qualified personnel too frequently not available in time ;
- marked reticence (if not refusal) by make-shift groups to answer the requests for assistance from the airport management.

We are therefore convinced that the most urgent task is to remind everyone about the permanent need for VIGILANCE.

Nevertheless, we believe that, within the framework of the already existing means, a pre-established, coordinated system of taking immediate action must be conceived and very quickly set up at every airport, under the direct responsibility of its management.

- In the context of the OVERALL SAFETY to be assured to users concerning at first the prevention of accidents and any material damage, it seems normal - and logical - that this system should be permanently ready for use by THE AIRPORT'S FIRE BRIGADE.

  Within this service and in parallel with the teams of firemen now provided for - or possibly made up of members of the latter to whom an additional role has officially been assigned - this system could consist of a SMALL SPECIALIZED EMERGENCY CREW with vehicles and equipment adapted to coordinated actions to frighten groups of birds away.

- As soon as an alert is given by radio, the emergency crew would immediately go to the area where large numbers of birds had been noticed.

  . It would have the mission of using the most efficient means at its disposal to guarantee the maintenance of free circulation of aircraft in landing or take-off paths and thus assure the permanence of their SAFETY.

  . Among the precise instructions given to this end, it might be specified that any action partially or totally to destroy these concentrations of birds could be taken at the initiative of the EMERGENCY CREW in the cases of extreme necessity when it is believed that the safety of aircraft and their passengers might be in danger.

- It would also be stipulated that, in such a case of absolute necessity, the action to be taken might include action against protected species of birds.

./.

We consequently think that, under the authority of the BSCE and of the ICAO, new international recommendations should be made as quickly as possible to :

. strengthen the present texts, insisting upon the idea of OVERALL VIGILANCE on the part of the airport's administrative services ;

. define in a precise way the various workloads and duties to be distributed among the various services as concerns :

- the means of detecting large flocks of birds on airport grounds ,

- the means of frightening away these birds,for use as soon as needed,

- the means of immediately informing the cockpit crews present at the airport,

- the means of quickly transmitting (by Bird Warning Messages) this information to all aircraft for which that airport is a scheduled destination ;

. require strict application of the new stipulations ;

. set up a new system of taking action that is simultaneously :

- coordinated, as regards the means of detecting, alerting, informing and transmitting ;

- immediate, as concerns the means of frightening away and, if necessary in the extreme case of large concentrations of birds or of an emergency just before a landing or take-off , the possible destruction of the birds, even protected species.

- Indeed it is increasingly clear that it is actually at the levels of surveillance, for which the airport's administrative services are responsible, and of both coordinated and immediate utilization of the means available at airports that serious unusual situations sometimes occur during which the possibility of accidents cannot be ruled out.

1.4. Conclusion

Most of the investigations into bird strike incidents show that the present absence of the proposed system is the real weakness of the entire system of protection set up at airports against bird risks.

We therefore believe that our comments and a reminder of our observations and of our preoccupations to the Members of this meeting will help emphasize the real interest that can represent for the maintenance of air safety our proposal of Recommendation No.1 concerning the urgent need to set up a coordinated system of taking immediate action at airports.

-=-=-=-=-=-

BIRD RISK AND AIR SAFETY

WP 31/2

/ PROPOSED RECOMMENDATION No. 2 /

2. ON THE ADOPTION OF A CLASSIFICATION OF THE TYPES OF INCIDENTS ACCORDING TO THEIR EXTENT AND DEGREE OF SERIOUSNESS

Aircraft "Bird Encounter" Incidents

Examination of the circumstances surrounding each bird encounter incident and recognition of the effects and damages of every sort that may have resulted from it have led us to the realization that the conditions met and the damage incurred are very different from one incident to another and even out of all proportion with each other.

- Indeed, a report on one incident may indicate that the aircraft passed near a group of birds -whether on the ground, taking wing, or in flight- but without there being the slightest impact.

  . In itself such an incident has no direct, immediate, adverse effect on operations.

  . It must, however, represent in the eyes of the responsible administration an alarm signal as regards the strict surveillance of the airport concerned.

  . It is therefore interesting solely as information on the presence of concentrations of birds on airport grounds and/or in the neighbourhood. Nevertheless, this information is often precious since it gives warning of the existence of a possible danger threatening the airport.

- Another report may state that the aircraft incurred a bird strike from one medium-sized bird (often the type of bird is not recognized) : here the danger to other aircraft is slight and even inexistent.

  . This is a minor operational incident.

  . Here no conclusion or deduction can be drawn from the mere occurrence, which remains exceptional, unpredictable, and unavoidable.

On the other hand, certain reports describe incidents that are far more important from the viewpoints of their consequences and the damages caused ; such damages may show themselves under different aspects and may or may not have a cumulative effect :

. material damage to the aircraft's superstructure,

. ingestion of one or more birds by one or more engines,

. operating procedure suddenly interrupted or modified,

. extended grounding of the aircraft,

. cancellation of the flight and transferral of the passengers to another flight,

. need for a ferry flight for the aircraft,

. without forgetting the adverse effect of all of these types of damage on the passengers' states of mind : an at least disturbing impression of insecurity, jeopardization of punctuality, inconvenience of the transfer to another aircraft, etc.

.../...

How, then, can we set up exact distinctions between incidents, particularly on the basis of their frequency at a given airport, their relative importance, the extent of the damages, and their essential characteristics as well as their particular circumstances : weather conditions, type of birds, possible accumulation of temporarily unfavorable conditions, etc. ?

- A selective order of classification of the incidents, including all of the factors that we have just mentioned can permit simultaneously :

  . a discrimination by category stressing the relative importance attributed to each incident by the responsible authority, and

  . an immediate, realistic visualization of the qualitative and quantitative relationships among all of the incidents, which the consultant or reader wishes first to consider and judge as a whole.

These considerations naturally led Air France as far back as 1975 to make up an order of classification for incidents of this nature, progressively indicating their extent and degree of importance.

To permit a better understanding of Air France's statistics, it was decided to return to 1971 and to classify retroactively all of the incidents recorded, thereby making the entire group of figures more meaningful.

This progressive order of classification (see below) consists of 5 representative categories covering all of the cases recorded : it is thus possible to attribute every "bird encounter" incident to one of these categories, after examining its degree of importance, adverse effects upon operations, and perhaps jeopardization of the safety of the aircraft and the persons being transported.

A - Many birds encountered near the flight path but without a single bird strike.

B - One or more birds encountered with one or more bird strikes but without visible material damage ; no delay in operations or other adverse effects.

- Then, one or more bird strikes or ingestions by one or more engines :

C - Appreciable material damage or delays or adverse operational effects (such as damaged radome, modification of engine speed, departure procedure delayed as much as 90 minutes for verification or cleaning, etc.).

D - Considerable material damage and/or long delays or important adverse operational effects (such as major repairs, change of engine, passengers transferred to the following flight -often on other airline - because of cancellation, return to departure airport after very serious bird strike and/or ingestion, of bird(s) by engine(s), aircraft grounded for 24 hours or more, ferry flight, etc.).

E - Sudden jeopardization of the safety of the plane and its passengers as well as considerable material damage and/or long operational delays (such as major repairs, change of engine, passengers transferred to the following flight -often on other airline - because of cancellation, return to departure airport after very serious bird strike and/or ingestion of bird(s) by engine(s), aircraft grounded for 24 hours or more, ferry flight, etc.).

.../...

According to the above selective classification order, Air France drew up, for its own purposes, a progressive classification of its incidents as far back as 1971 in the form of the following recapitulative chart, which we are showing as a characteristic -and, we believe, convincing - example as concerns the rapidity with which the overall problem can be visualized thereby.

To this chart were added the 19 "bird encounter" incidents reported by Air France's cockpit crews between January 1 and May 15, 1978 (that is, merely across four and a half months) :

SELECTED INCIDENT CATEGORY	1971	1972	1973	1974	1975	1976	1977	from Jan.1, 1978 to May 15, 1978 (i.e., $4\frac{1}{2}$ months)
A	1	2	2	2	3	5	6	2
B	25	10	9	9	13	7	20	10
C	18	6	1	7	1	5	3	3
D	8	9	5	5	1	2	-	1
E	-	-	2	4	4	3	-	3
ANNUAL TOTAL	52	27	19	27	22	22	29	19

General Examination of These Air France Statistics

As for the serious incidents (Categories D and E), study of the above chart shows that :

- grouped together these two categories of incidents occurred for the first time in 1973 : .... 7 cases
- grouped together these two categories of incidents went up in 1974 : .... 9 cases
- then their number went considerably down in 1975 : .... 5 cases
- the same level was maintained in 1976 : .... 5 cases
- then there was a total disappearance of these types of incidents in 1977 (despite an overall increase in the total number of incidents reported : from 22 in 1976 to 29 in 1977)
- finally, and suddenly, since the beginning of 1978 we have recorded a proportionally very large increase in the total number of incidents, with the reappearance of serious and very serious incidents like those mentioned previously, especially between 1973 and 1976, and particularly as concerns category E.

Among the most important incidents that have occurred since January 1978 must be mentioned :

- 1 serious (Category D) incident during a landing at Baghdad on February 14, 1978, and

- 3 very serious (Category E) incidents all during take-off : at Houston on January 22, 1978, at Lyon Satolas on February 18, 1978, and at Paris Charles de Gaulle on March 16, 1978.

Confronted with this new, very disquieting situation indicated by the four serious or very serious incidents during the first quarter of 1978, we must ask ourselves whether the four airports involved had already been the scenes of other bird encounter incidents during 1977 and the beginning of 1978.

This question leads us to examine the airports concerned, and a thorough study of this problem shows the necessity of setting up a second order of classification, that of the airports, on the basis of their degree of progressive or undisputed bird risk.

Within this overall order of classification each airport studied can be given the (temporary) classification apparently fitting it most closely on the basis of the bird risk data already reported in its case.

It is clear that the assignment of this classification may sooner or later change, for the airport may improve its "critical" standing as to bird risk -or on the contrary allow it to worsen, if other incidents of the same nature (which may be yet more serious) occur at or near it.

This second order of classification is precisely the object of our Proposed Recommendation No.3, attached hereto.

Nevertheless, as concerns our Proposed Recommendation No.2, about adoption of an order of classification of the categories of incidents on the basis of their extent or degree of seriousness, we think that, with an aim to simplify the statistical presentations to the BSCE, it would be wise to consider its regular usage, as it has already been used by Air France for several years now, with the agreement of the French Administrative Services of the "Direction de la Navigation Aérienne" and of the "Inspection Générale de l'Aviation Civile".

BIRD RISK AND AIR SAFETY

WP 31/3

/ PROPOSED RECOMMENDATION No.3 /

3. ON THE ADOPTION OF A CLASSIFICATION OF AIRPORTS ACCORDING TO THEIR DEGREE OF PROGRESSIVE OR UNDISPUTED BIRD RISK

Taking into account what was just explained in proposed Recommendation No.2, it seems necessary, supposing that a classification of the categories of INCIDENTS will be adopted, to complement this first classification with a second one classifying AIRPORTS according to their degree of progressive - or even undisputed - bird risk.

This second classification should give rise to several valuable effects :

. concentrating the vigilance of the administrative services responsible to their respective States on a small number of airports at which an undisputed bird risk exists or reappears ;

. keeping the managements of the airports involved as conscious as possible of the latent threat to the safety of the air traffic placed under their protection ;

. informing in a positive manner the managements of the airline companies about the relative risk really represented by a specific airport in their day-to-day operations , thereby enabling them to undertake any action towards the responsible government services to obtain a rapid improvement of the present situation before any further incidents take place ;

. furnishing the Flight Captains with clear information about the degree of bird risk that certain airports can represent to their flight operations, thereby encouraging them :

- to ensure a closer surveillance of the sites during approach and landing flight phases and before take-off,

- to ask for assistant from Air Traffic Control or immediate action from the airport's safety services, the mission of which is precisely to provide this.

Nevertheless, an examination of the various conditions according to which an airport can be classified in the context of the bird risk situation threatening it and - above all - the judgement of the degree of risk represented remain difficult to carry out and must be subject to periodic or at least long-term changes, depending on the particular case involved.

Indeed in this field nothing can be systematic ; everything seems to be a matter of factors and the probabilities of risks evaluated in terms of a thorough knowledge of the airport concerned : the constant follow-up of its day-to-day operations, of its local or regional problems with birds, of its environment and climate, and finally of the extent of the means of prevention and protection put into place by the official services - without forgetting observance by the responsible ground services of the indispensable surveillance required by regulations.

./.

Thus, on the basis of studies made into the four serious incidents that occurred to Air France's aircraft during the first 4 and $\frac{1}{2}$ months of 1978 (Baghdad, Houston, Lyon-Satolas, and Paris-Charles de Gaulle), we wished to be able to answer the following question raised by our management : "Had other bird encounter incidents taken place at these four airports during 1977 and the beginning of 1978 ?"

For Baghdad and Houston the answer was no. In fact an extra verification also established that these two airports had not been the scenes of any such incidents with Air France planes since January 1975.

On the other hand, since January 1977 several bird encounter incidents, which were not serious (Categories B or C) - and as far as Lyon-Satolas was concerned, without there being any worrisome problem as to large groups of birds - had been reported by Air France crews at the other two airports, as follows :

. LYON-SATOLAS : 2 earlier incidents :

- on March 8, 1977 - B 727 - during descent to Lyon, at 7 000 ft - impact with a single bird - incident classified as CATEGORY B.
- on June 25, 1977 - B 727 - during landing (but before touchdown) - one impact during encounter with 4 buzzards - incident classified as CATEGORY B.

. PARIS-CDG : 5 earlier incidents :

- on January 25, 1977 - B 707 - during take-off, while still on the runway - several impacts with pigeons - incident classified as CATEGORY B.
- on February 14, 1977 - A300B - during approach, at 5 000 ft - impact with a single medium-sized bird - incident classified as CATEGORY B.
- on March 9, 1977 - SE 210 - during descent to CDG, at 6 500 ft - impact with a single large bird - incident classified as CATEGORY C.
- on January 10, 1978 - B 747 - during take-off, while still on the runway - several impacts with seagulls - incident classified as CATEGORY B.
- on March 11, 1978 - A300B - during climb, at 10 000 ft - several impacts with starlings - incident classified as CATEGORY C.

These data suggest that each airport presents a specific bird risk probability on the basis of the consideration of several criteria : its geographical situation, the migratory phenomena affecting it (whether periodic, continental or regional migrations and/or almost constant local micro-migrations), the relative size of the groups of birds staying there, the possibility of there being several different types of birds, the frequency with which the cockpit crews report incidents with each type, the relative importance of these incidents, the specific circumstances met, and finally the means of prevention and/or protection set up by the official airport services.

./.

From the above it is clear that it is absolutely necessary to set up, on the widest possible scale, a special selective classification of the airports, showing their probability of bird risk : such a classification will also present the advantage of singling out the airports at which an undisputed bird risk persists.

After a very detailed analysis of the various different factors to be taken into consideration, we carried out a study covering ALL of the recorded cases and then made a classification of the categories of airports on the basis of the probability of risk characterized by each.

With the intention of making the two classifications follow the same logic, we set up this second classification of the progressive risk according to 5 representative categories covering ALL of the situations met at airports during a given period.

As already indicated, the assignment of one of these categories to any airport remains subject to modification - if not annually at least regularly - on the basis of the development of the general situation involved.

CLASSIFICATION OF THE CATEGORIES OF AIRPORTS

We are giving below Air France's classification, as of January 1, 1978, of the categories of airports.

A : No bird encounter incident has as yet been reported by a cockpit crew - nor has any worrisome information been brought up as concerns the presence of large numbers of birds at the airport.

B : A single incident (or several isolated incidents across a period of several years : 3 years, for instance) has been reported without any or very slight resultant damage ; what is involved here is a single bird or only a very small group of birds.

C : Infrequent incidents have been reported, which were caused by single birds or small groups of no more than 10 birds, whether with or without impact, thereby not constituting a problem of large flocks of birds coming regularly to or staying constantly on the airport grounds or in the immediate neighbourhood.

D : Several more or less important incidents have already been reported and the bird strikes incurred by the aircraft took place during encounters with large flocks of birds regularly or constantly found at or near the airport and/or a report (from a cockpit crew, from the airport or from an official service) has been received indicating large numbers of birds on or near the airport grounds, or in a neighbouring area which is particularly attractive to birds, such as a seashore, swamp,lake, pond, garbage or farm dump, sewer outlet in the sea, etc.

This cagegory of a sizable risk shall be maintained for the airport involved whatever the means of prevention or protection against birds set up by the airport's official services, as long as the large numbers of birds reported remain at or near the airport or in neighbouring areas that are particularly attractive to birds.

E : Several major incidents and/or at least one serious incident have already been reported, and the bird strikes incurred by the aircraft took place during encounters with concentrations of at least 1000 birds, whether regularly or constantly on or near the airport grounds.

This category of maximum risk shall be maintained for the airport involved whatever the means of protection or prevention against birds set up by

the airport's official services, as long as the concentrations of birds reported remain on or near the airport grounds or in neighbouring areas that are particularly attractive to birds.

As can be seen, this classification schematically brings out 3 major types of cases which must be differentiated.

1. Airports at which no undisputed bird risk is to be found

   (Categories A and B)

   We have included Category B here, as an impact with a single bird always remains possible at any airport and represents an exceptional, unpredictable and unavoidable case.

2. Airports at which a slight bird risk may exist

   (Category C)

3. Airports which are particularly worrisome (Categories D and E), and for which all indispensable, systematic means must be set up as quickly as possible by the responsible administrative organizations, such as :

   . efficient means of prevention and protection set up against bird risk at the airport ;

   . systematic furnishing of information to the cockpit crews who are in the approach phase or about to take off, concerning every concentration of birds on or near the airport grounds ;

   . setting up of a specialized emergency crew at the airport, ready :

   - to receive immediate warning from Air Traffic Control,

   - to go at once to the reported area of bird concentration,

   - to take quick action, in order to : frighten away, neutralize or destroy the concentrations of birds so that all risks of bird impact will be eliminated on the runway to be used and in the airport's take-off, approach and landing flight paths (cf. the first Proposed Recommendation on the urgent necessity of setting up a system of taking immediate action at airports).

IMPORTANT REMARK

We wish formally to point out that this new order of classification is not meant to be of a disparaging or discriminatory nature against those airports at which it is generally recognized that a regular or constant bird risk has existed and continues to exist - that is, Categories D and E.

. On the other hand, contrary to any necessarily subjective and "negative" idea of black-listing, we recommend the putting into application of a new concept of GENERALIZED ASSISTANCE to the airports of these last two categories, which,we agree, are the victims of unfortunate, sometimes frequent and lasting natural factors which affect them first of all.

. This generalized assistance might particularly call upon the help of the following organizations :

1. the national administrative services of the airport concerned,

2. the commercial airlines operating into and out of the airport.

   The active assistance of the latter would result particularly in :

   - immediate, systematic information about every more or less sizable concentration of birds reported on or near the airport grounds, which every Flight Captain would be made responsible for immediately reporting, together with all other useful information ;

   - every possible assistance, information, or contribution of any nature whatsoever concerning this risk by the operational personnel of the airlines on duty at the airport within the framework of their possibilities and competence.

MEANS OF APPLICATION OF THIS METHOD OF CLASSIFICATION

1. Period to Be Taken into Consideration

   For the field of application of this method of classification, we think that the taking into consideration of a previous, neither very short nor very long period would give us the significance on a medium-term basis of the overall bird risk situation at an airport.

   With this in mind, we suggest a period of three years prior to the year of classification.

2. Organizational Procedure

   The new procedure as to the organization and processing of the pieces of information, the elements on which a judgment can be reached and the elements of classification of the airports (first of all, the European airports under the authority of the B.S.C.E.) could take place on three successive levels :

   . for the first two levels, it would use the already existing organizations that are concerned with the problem ;

   . for the third or top level, it would request the setting up of a :

   European Commission for the Assignment of Airport Classifications

   which would be formed from within the Bird Strike Committee Europe.

3. Operation of the New System

   . At the 1st level : the commercial airlines

   On the basis of their day-to-day operations at the airports of their European networks and after a first synthesis of the very diversified but also limited data at their disposal, the commercial airlines would make

   ➧ ANNUAL CLASSIFICATION SUGGESTIONS.

   . At the 2nd level: the national administrative organizations

These organizations would centralize the classification suggestions sent out by the various airlines about the European airports used as destinations or alternate (diversion) stations by the airlines.

They would examine the suggestions and might modify the classifications after reaching a synthesis of the various elements of appreciation recorded.

They would then make up

➧ ANNUAL CLASSIFICATION PROPOSALS.

. At the 3rd level : the European Commission for the Assignment of Airport Classifications

The future commission formed from within the Bird Strike Committee Europe , would have the annual mission, on a European level, of :

- centralizing in its turn all of the classification proposals communicated by the Member-States,

- examining and perhaps modifying the classifications proposed by each State, after a final, careful synthesis ;

- proceeding, for all European airports, to make offical, published

➧ ANNUAL CLASSIFICATION ASSIGNMENTS .

4. Time Limits for Classification Processing

The overall time limits should be compatible with the necessity of using the surveys and studies as well as the various transmission times for the information and files but must not, overall, exceed a reasonable limit, which we believe should be no longer than one year.

This could be broken down chronologically as follows :

(a) During the 1st Quarter of Each Year.

Upon making a complete list of the Bird Risk incidents across the previous year, each airline should send in its suggestions for the classification of the airports at which it operates to the national administrative organization : for instance, the DGAC in France.

(b) During the 2nd Quarter of the Year.

After asking each airline to furnish a list of incidents and suggestions as to the category to be assigned to each airport, each national administrative organization would forward its proposals as to airport classifications to the BSCE's European Commission for the Assignment of Airport Classifications.

(c) During the 2nd Semester of the Year.

Taking into consideration the time limits set up and its assigned mission, the future European Commission for the Assignment of Airport Classifications would then take the necessary steps so that it would be able officially to publish towards the end of the year (in December, at the latest) a list of classifications on

./.

which each airport will be assigned an annual category in conformity with the 5 representative categories of our 3rd Proposed Recommendation.

Let us recall that there will always be the possibility of changing the category one year later.

Thus, by merely glancing at this annual list, every flight captain would immediately be informed about and made sensitive to the degree of bird risk represented by any given airport at which he proposes to land during his tour of duty.

CONCLUSIONS

This third proposed recommendation constitutes the last part of the triptych of a coordinated system in which the following elements are assembled and integrated, in close relation with the various means already set up, i.e. :

. immediate protective action, according to a system to be used throughout Europe ;

. a synoptic classification :

- of the INCIDENTS according to their exact respective importance,

- of the AIRPORTS according to their greater or lesser degree of bird risk, in a form which is immediately meaningful to flight captains.

We therefore thought it useful and desirable for these three complementary proposals to remain associated in the eventuality that they are examined and agreed upon by the persons who take part in the BSCE.

Let us recall that, in answer to our wish, the Chairman of the AERODROME Working Group requested and obtained from the Plenary Meeting of the BSCE held in Berne on June 1, 1978 that the three proposals be the subject of later discussions so that they could then go through normal channels and be adopted by the BSCE in the form of "Recommendations" to the Member States.

We believe that these three proposals can ultimately present the appreciable advantage of constituting, at least in a first stage, for all of the European States involved, a common language of practical, clear coördinated action, method and synthesis such that it makes exchanges of information and dialogues easier both at the level of the BSCE Member States and at that of all of the individuals and organizations interested in the maintenance - at every instant - of the safety to be assured to air traffic users at the airports subject to their authority or placed under their surveillance.

-=-=-=-

ADF 616 107

W.P. 30.

Dr. Trunov
MR. ROGATCHEV.

BIRD STRIKES TO AEROFLOT REGISTERED AIRCRAFT AND SOME GENERAL AIRWORTHINESS REQUIREMENTS

The level of flight safety is characterized by the probability of an aircraft accident. For aircraft that are operated on scheduled world airlines the probability of an accident falling on one flight is now close to the value of 10^{-6}. It means that several accidents occurring due to various reasons fall on each million of flights. Out of this amount of reasons the role played by birds is relatively small, as also small is the part of each reason taken separately. However no one will presently doubt the actuality of the problem involving protection of aircraft against birds the collisions with which, although rarely lead to accidents, but cause great damage to aviation and create constantly hazard to flight safety.

In so far as the operational experience has shown that aircraft birdstrikes cannot be avoided inspite of the measures taken, some requirements for bird-impact resistance of aircraft structures have been introduced into the airworthiness standards of a number of countries. These requirements related primarily to engines and some structural elements of an airframe can now be discussed again on the basis of research and flight experience accumulated.

Three main directions can be put forward when we are concerned with aircraft and helicopter birdstrike problems:

- firstly, the study in the interests of aviation of "ornithological medium" (numbers, species of birds, their migration routes, concentrations, density of bird flocks, bird weights and sizes,etc).
- secondly, investigations into the effects of "ornithological medium" on aviation;
- thirdly, development of recommendations, measures and means to reduce bird hazard to aviation.

It is along these three main directions that the work is essentially conducted by the six working groups of the European Bird Strike Committee (BSCE).

As can be seen from practice, tangible success in reducing bird hazard to civil and military aircraft can be achieved only by a com-

plex of steps among which not the last place belongs to the designing of bird-impact resistant aircraft structures. The designing of birdproof aircraft or helicopters is hardly realistic. We can understand those designers of aircraft and their engines who adduce rather convincing arguments in favour of solving the problem as a whole, primarily, by way of moving birds off an aircraft route, since the strengthening of aircraft structures inevitably entails an increase in weight and other aftereffects that impair the performance characteristics of an aircraft. However, airworthiness standards must include minimum requirements that would provide flight safety in case an aircraft strikes a bird or a bird flock inasmuch as this cannot be avoided; that is why, in working out such requirements one should proceed from general principles used in setting up airworthiness standards.

Almost any aircraft accident, being a corollary of quite definite causes, is at the same time accidental in nature as it springs from accidental coincidence of a number of factors. Therefore, the probabalistic approach that has been widely spread recently is the only valid one in working out general requirements for flight safety. Thus, if absolute safety of flights is unattainable, our objective must consist in ensuring minimum probability of an aircraft accident.

The airworthiness standadrs for civil aircraft in the USSR (AWS-2) include clauses that state merely a general requirement the essence of which boils down to the following: an aircraft must be designed and constructed so that at any stage of flight in all, the so-called, expected operating conditions the occurrance of a catastrophic situation is practically improbable, provided the crew's actions are correct. When working out airworthiness requirements for bird-struck aircraft, one should proceed from this general assumption.

Particular bird-impact resistance requirements for passenger aircraft structures contained in the USSR standards are close to those that are now universally accepted and based mainly on the FAR and BCAR requirements. These requirements relate to pilots' cabin canopy glass and to engines. Pilots' cabin windscreens should withstand an impact by a bird weighing 1.8 kg with an aircraft flying at its maximum operating speed and an altitude of 2500 m. Damage to bird-struck

engines should not lead to dangerous effects and must not prevent the aircraft from continuing its flight to the destination aerodrome. In this case, three bird categories are implied:

- one large (weights of 1.8 kg);
- several medium (weights from 0.5 to 0.7 kg);
- several small birds (weights up to 115 g).

For now, the USSR airworthiness standards (AWS-2) do not contain bird-impact resistance requirements for aircraft airfoils. As is known, the USA and UK standards contained requirements for empennage structure which must withstand without dangerous effects an impact by a bird weighing 3.6 kg (FAR) and 1.8 kg (BCAR). However, these requirements are probably based on single incidents taken from operational experience, which, among other things, explains the difference in bird weights between the US and UK standards.

When considering particular bird-impact resistance criteria contained in airworthiness standards of various countries, one cannot, but agree with the opinion that the requirements do not take fully into account a number of factors. For example, aircraft/bird collisions at high altitudes. Therefore, from our point of view, it is important that we should continue accumulating statistical data on bird sizes and weights, the density of bird flocks, on altitudes and speeds at which aircraft birdstrikes occur, which will, in the long run, allow us to determine more exactly the probability of emergency situations and this, in its turn, will enable us to refine the rated conditions and normalized parameters of birds.

As an example, we can provide the following collisions of birds to Aeroflot registered aircraft and helicopters which occurred in 1977 - 1979 and involved different effects:

(1) October 4, 1978, aircraft Yak-40 on take-off at dark time, under simple weather conditions from one of the aerodromes in the Kamchatka struck a flock of sea gulls (Larus marinus) at an altitu- of about 15 to 20 m. Two engines were shutdown immediately and the aircraft made a forced landing on a sand beach. The remains of more than 20 killed birds were found on the runway (Fig. 1). A typical example of an emergency situation which did not pass into an accident due to prompt and careful actions of the aircraft crew.

(2) September 14, 1978, aircraft An-2 on take-off in the morning

under simple weather conditions from an aerodrome in the Volga region struck a flock of common gulls (Larus ridibundus) at an altitude of about 5 to 10 m. The birds struck the pilots' cabin glazing and the engine. The engine failed. The aircraft landed safely on the stopway.

(3) August 1, 1978, aircraft An-2, while carrying out aviachemical operations on the territory of the Azerbaydzhan Soviet Republic, struck a grey crow (Corracias garrulus) at an altitude of about 20 m. The bird struck the engine with a consequence that it started feathering. The aircraft made a forced landing on an unprepared strip and was broken.

(4) June 14, 1979, at 13.00 hours, aircraft Tu-154 during the descent in the area of the town of Chita struck a bird, assumingly an eagle, at an altitude of 4400 m. The aircraft suffered a hole in the skin, measuring about 30 x 40 cm (Fig.2), but landed safely.

(5) An interesting example can be found in the incident when helicopter Mi-8 struck a loon. On June 26, 1977, at 7 o'clock in the morning helicopter Mi-8, while flying at a speed of 160 km/hr and an altitude of 100 m, struck a loon in the area of the airport of Surgut. The bird broke through the cabin windscreen, but remained alive (Fig.3). The helicopter commander was slightly injured. The helicopter made a forced landing.

It is likely that a general airworthiness requirement for a birdstruck passenger aircraft can be worded as follows: the flight performance qualities and the construction of an aircraft must enable, when colliding birds, the flight to be completed without involving an emergency situation*.

This general requirement must be made more specific as applied to engines, airframe and the systems of an aircraft. The functioning of vital systems and units of an aircraft must be ensured in aircraft birdstrikes. For example, in all cases, an impact by a bird must not lead to the failure of the aircraft control system, since it would involve a catastrophic or an emergency situation.

The highest hazard to flight safety and the worst economic effects of aircraft birdstrikes are caused by bird ingestion into eng-

---

* As the USSR airworthiness standards (AWS-2) put it, an emergency situation is a specific situation in which its transition to a catastrophic one (involving loss of human lives and aircraft) can be prevented only by way of particularly great physical and psychophysiological loads on the crew and by high professional skill of the crew members.

ines. The consequence of such ingestions is either damaged engines or impaired performance parameters, or both at a time. Although, for a modern multi-engine transport aircraft, failure of one engine is not regarded in the airworthiness standards as an emergency situation, but only as a complication of flying conditions, cases are possible when disintegration of engine elements (for example, compressor blades) causes dangerous damage to other components of an aircraft and other engines, which may involve an emergency situation. Standards requirements must take into account such factors.

An example was given above when a birdstrike caused a shutdown of two engines on aircraft Yak-40. As an example, another incident can be given to describe damage to engines struck by birds. On August 7, 1979, aircraft Tu-134 on take-off in the airport of Leningrad in rain conditions and at limited visibility struck a flock of gulls, which caused a failure of the right-hand engine at an altitude of 30 to 40 m; The aircraft went round again and then landed safely. During inspection on the ground considerable damage to the engine (stator blades, the first, second and third compressor stages) was found. (Fig. 4).

Designers are working at the problem of protecting engines against birds. Several directions can be put forward in this work:

- the strengthening of the engine structural elements;
- improvements in its gasdynamic stability;
- development of protecting devices to prevent birds from getting into the engine or into its most vital elements;
- easy replacement of damaged elements of the engine;
- application of new "imactproof" materials in the engine structure.

Inspite of a great complexity in solving, as a whole, the problem of improving the bird-impact resistance of an aircraft and its engines, the requirement to raise the level of airworthiness of a modern transport bird-struck aircraft becomes now more and more burning. The task consists in the following: on the baisis of reliable statistical data and the results of special research work we should work out (refine) respective requirements in airworthiness standards with due account being taken of the reality of their future implementation.

Collisions of USSR Civil Aircraft and Helicopters with Birds In 1977 - 1978

The USSR civil aviation experienced 163 recorded collisions of aircraft with birds in 1977 and 182 collisions in 1978, which approximately corresponds to the level of the previuos years. These figures probably indicate that we have certain progress in solving the aircraft birdstrike prevention problem inasmuch as the intensity of air traffic and the numbers of some bird species (gulls, crows and others) are increasing.

In 1977 and 1978, same as in the previous years, the majority of the recorded collisions of aircraft with birds accounted for incidents that involved damage to aircraft, engine replacement, forced landing and other adverse effects. There were 90% of such cases in 1977 and 85% in 1978. However, as it was mentioned above, this rate could stem from an incomplete account of all incidents, which is quite probable.

On the whole, as a result of collisions of aircraft with birds in 1977 and 1978, 157 engines were damaged and removed ahead of schedule, 40 forced landings were made.

Table 1 shows the distribution of birdstrike incidents by the types of aircraft for the whole period of 1977-1978.

It follows from Table 1 that birdstrikes most frequently happen aircraft An-24, Yak-40, Tu-134 and Il-18. This is explained, first of all, by the intensive and widespread use of these aircraft.

On the whole, turboprop aeroplanes accounted for 50% of birdstrikes, turbojets accounted for 40% (10% as high as compared with the previous years), piston airplanes accounted for 8% and helicopters, for 2%.

Aircraft An-24, Yak-40, Tu-134 and Il-18 suffered the greatest number of damaged and removed engines. In 1977-1978, same as before, incidents were recorded when birdstrikes involved damage and unscheduled removal of 2 engines at a time: An-24 in three cases, Il-18, Tu-134 and Yak-40 in one case; three engines were algo damaged in one case which happened to An-12.

It also follows from Table 1 that seven incidents resulted in impacts by birds on the pilot's cabin glazing with subsequent brekdown of the glazing. It should be noted that in three incidents large birds (eagle, crane, loon) were involved, in one case pigeons and in three incidents the birds were not identified.

In 1977 - 1978 aircraft birdstrike incidents were distributed by altitudes as follows:

up to 101 m	- 54%
101 to 400 m	- 31%
401 to 1000 m	- 8%
1001 to 2000 m	- 5%
over 2000 m	- 2%.

The majority of birdstrikes were recorded at altitudes ranging from 0 to 101 m, as the ground air layer features the most intensive migration of birds. Several incidents involved collisions of aircraft with birds at high altitudes: 2500 m (aircraft An-24, March 18, 1978, in the area of Makhachkala), 2700 m (aircraft Il-18, May 3, 1977, in the area of Kazan; Yak-40, May 2, 1977, in the area of Chardzhou; Il-62, July 13, 1978, in the area of Semipalatinsk); 3000 m (aircraft An-12, May 10, 1978, in the area of Tjumen) and 5100 m (aircraft Yak-40, May 11, 1977 in the area of Stavropol).

It should be noted that the distribution of incidents by altitudes varies in different periods of the year, which is conditioned by a specific ornithological situation associated with seasons (Table 2).

Weight categories of birds involved in aircraft collisions were identified in 1977 - 1978 in 148 cases and bird species were identified in 127 incidents.

Out of these numbers small-size birds (weighing up to 110 g) accounted for 22% of strikes, medium-size birds (weighing from 110 to 1810 g) accounted for 63% and large-size birds (weighing over 1810 g) accounted for 15% *. A comparatively low number of collisions with small birds, which are most numerous in nature, can be explained by the fact that collisions with them frequently do not involve any damage to aircraft and therefore they are unnoticed and not recorded. However, it does not mean that small-size

* By the statistics of six European countries the number of collisions with birds weighing over 1.8 kg is less than 1%, which also is indicative of an incomplete account of birdstrikes to the USSR civil aircraft.

birds are not a serious hazard to aircraft flights. This is confirmed by a collision of aircraft An-12 with a swift (Apus apus) on July 31, 1979. The aircraft took off at 19.15 in the airport of Kishinev and landed at 21.50 in an airport of Moscow. During the flight the crew members felt no impact and noticed no birds. However, afterflight inspection revealed a hole of about 10 cm in the starboard wing and swift's feathers that stuck in the hole (Fig. 5). The nature of the damage allows us to assume that the impact occurred at an altitude of several kilometers. This collision could also occur during descent at an airport of Moscow, i.e. after sunset. In the latter case, the collision would confirm the opinion of some ornithologists that after sunset swifts climb to high altitudes and remain there during the whole night.

In 1977 - 1978 most frequent were collisions of aircraft with the following birds: gulls (Larus) - 26%, pigeons (Columba) - 19%, birds of prey (Falcones) - 14%, sparrows (Passer), swallows (Hirundinidae) and starlings (Sturnidae) - 12%, ducks and geese (Anatidae) -10%. Attention should be drawn to the fact 1977 - 1978 marked a sharp increase in the frequency of collisions with gulls (12% as high).

The geographical analysis of the data on the USSR civil aircraft birdstrikes collected during a period of several years (since 1970) has shown that collision conditions and bird species vary substantially with various regions in the USSR.

In the region including the Baltic Sea district, Karelia and the Kolsk peninsula the majority of recorded collisions involved gulls (73%). It should be noted that collisions of aircraft with gulls are recorded not infrequently also in other northern districts of the Soviet Union. In the region under consideration birdstrikes are most frequently recorded in September and March (Baltic sea district) and in April (Karelia). The overwhelming majority of collisions are marked in the daytime and at altitudes up to 400 m.

In the region including Belorussia, the southern districts of the European part of the USSR and the Volga district the majority of recorded collisions involved pigeons (66%); a very high percentage of collisions occurring at night (60%) and a higher than aver-

age percentage of collisions occurring at altitudes over 1000 m. In the southern districts of the European part of the USSR comparatively frequent are recorded collisions of aircraft with waterbirds and birds of prey. The maximum number of collisions in this region are marked in April-May and October (Belorussia, in August).

In the central districts of the European part of the USSR the greatest number of collisions involve birds of prey and gulls. A maximum of collisions falls on July-August. Comparatively many collisions were recorded at altitudes over 1000 m (32%).

Comparatively few collisions of aircraft with birds were recorded in the northern and eastern districts of the European part of the USSR and also in the North Caspean district. However, from the available data one can assume that distinctive features for these districts are as follows: a variety of bird species are involved in collisions with aircraft, a maximum of collisions falls on September-October and the overwhelming majority of collisions occur at altitudes up to 400 m.

In the Urals and in the mountainous districts of South Siberia the recorded aircraft birdstrikes involve primarily pigeons. A maximum of collisions is marked in August. In the Urals, comparatively frequent are collisions of aircraft with crow-type and water-birds. Besides, an insignificantly expressed maximum of collisions is marked in June.

In the Caucasus the majority of recorded collisions involve gulls, birds of prey and small sparrow-type birds. A maximum of collisions falls on February, June and September. Relatively many collisions occur at night (55%) and at altitudes over 1000 m (20%).

In the flat districts of Middle Asia most frequently recorded are collisions of aircraft with pigeons and small sparrow-type birds (total of about 65%). A maximum of collisions is marked in March, May and Semtember. Collisions are basically recorded at altitudes up to 400 m.

In Central Kazkhstan the majority of recorded birdstrikes involve pigeons, birds of prey and crow-type birds (approximately in equal percentages). Most frequently collisions are marked in

spring and autumn (a maximum is not expressed) and at altitudes up to 100 m (75%).

In the mountainous districts of Middle Asia the majority of recorded birdstrikes involve birds of prey. A maximum of collisions falls on Augus-September. Relatively many collisions are marked at altitudes over 1000 m (15%) and also at night (45%).

Table I

Distribution of Bird Strikes by Aircraft Types (1977-1978)

Aircraft type	Number of bird strikes	Number of engine strikes	Number of engines damaged and removed	Number of windscreen strikes	Number of windscreens damaged
1	2	3	4	5	6
Turbojet					
Yak-40	56	36	28	5	1
Tu-134	48	24	16	6	-
Tu-154	13	4	3	2	1
Tu-124	9	7	5	-	-
Tu-104	4	6	4	-	-
Il-62	8	1	-	1	-
M-15	2	2	2	-	-
Total:	140	80	58	14	2
Turboprop					
An-24	113	63	54	5	1
An-12	12	10	7	1	-
Il-18	41	32	24	4	-
Total:	166	105	85	10	1
Piston					
An-2	25	8	6	2	1
Il-14	4	-	-	1	1
Total:	29	8	6	3	2
Helicopters					
Mi-2	3	3	3	-	-
Mi-6	1	1	1	-	-
Mi-8	6	4	4	2	2
Total:	10	8	8	2	2
All in all:	345	201	157	29	7

Table 2

Distribution of Bird Strikes
by Months and Altitudes (1977-1978)

Months \ Altitudes (m)	up to 100	101 ÷ 400	401 ÷ 1000	1001 ÷ 2000	over 2000
January	2	1	-	-	-
February	2	-	-	-	-
March	3	2	4	-	1
April	5	5	4	-	-
May	9	4	3	4	4
June	12	8	3	-	-
July	21	8	2	1	2
August	19	11	5	5	-
September	17	12	4	2	1
October	6	8	-	2	-
November	5	4	-	-	-
December	9	2	-	-	-

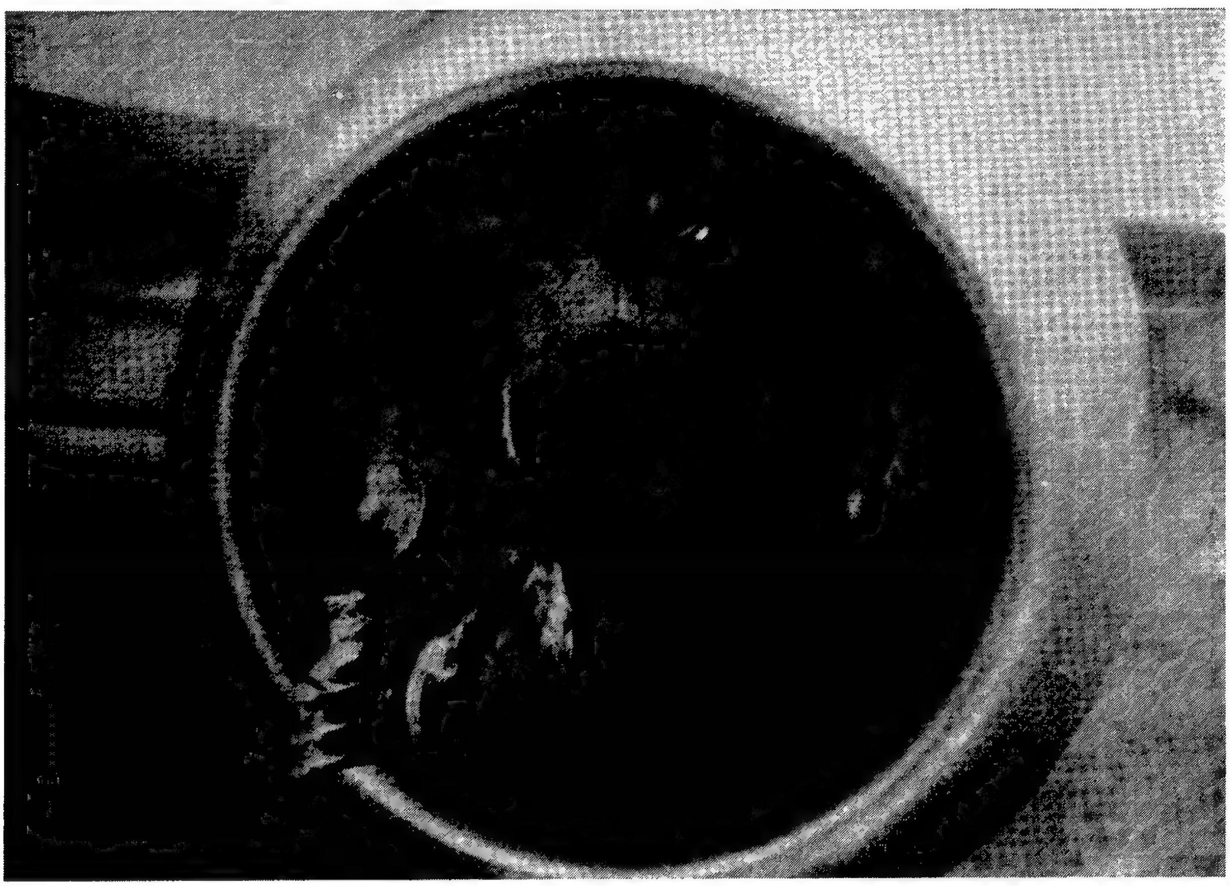


Fig. 1a

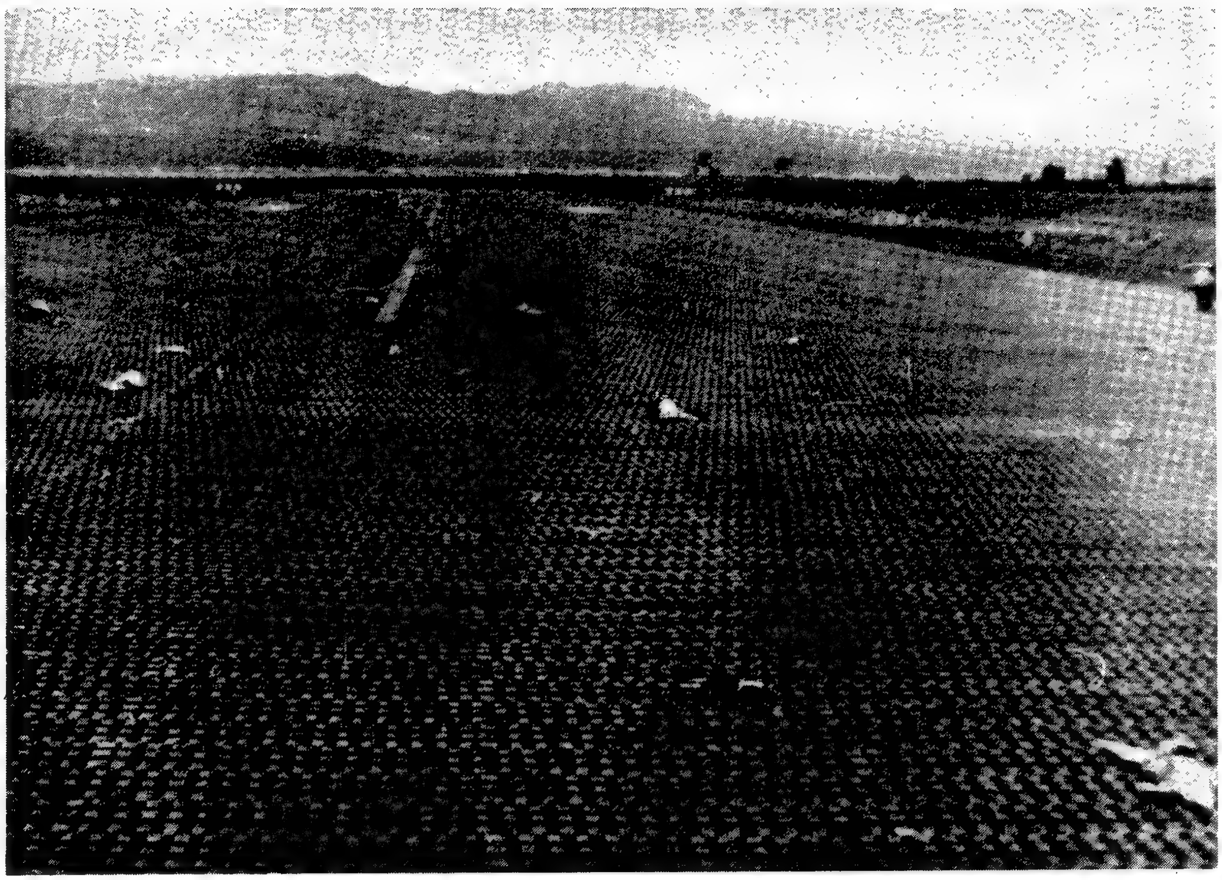


Fig. 1b

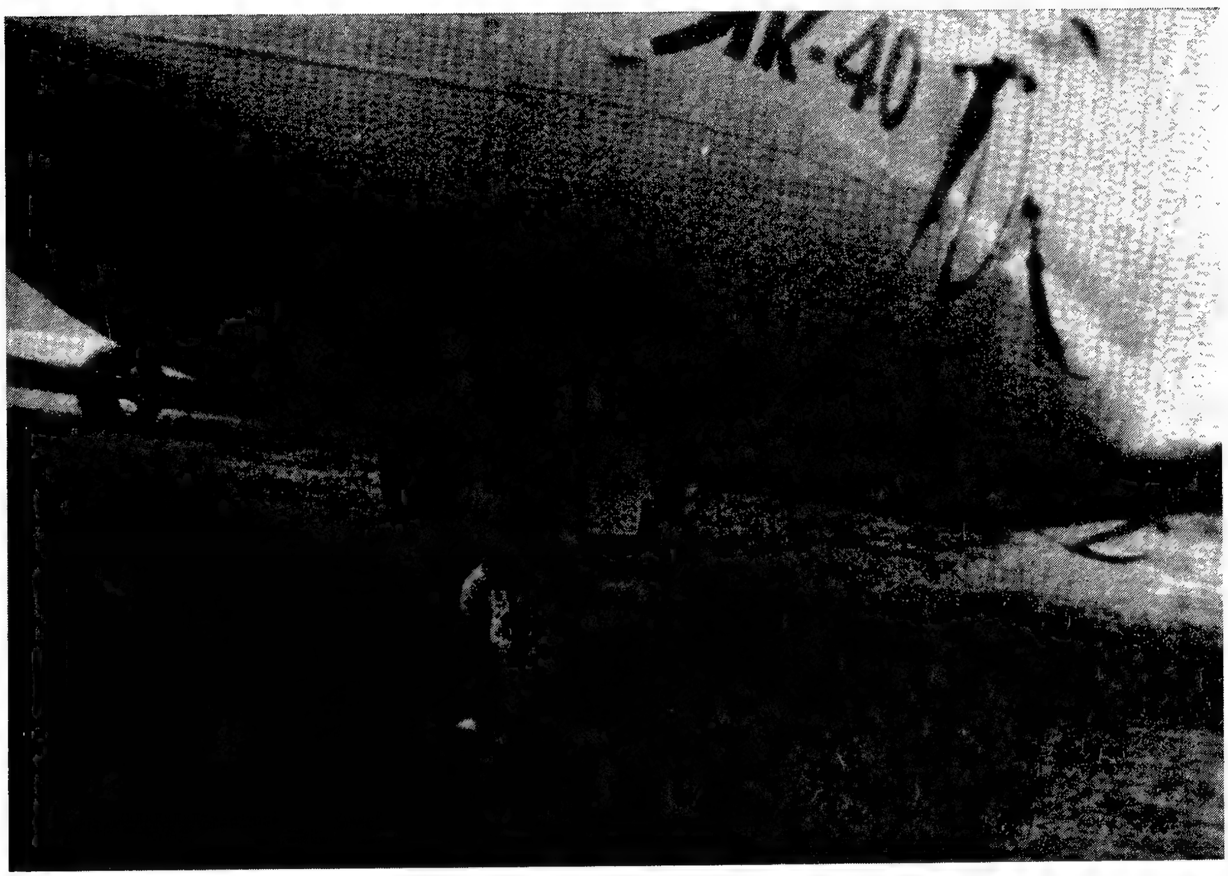


Fig. 1c

Fig. 1d

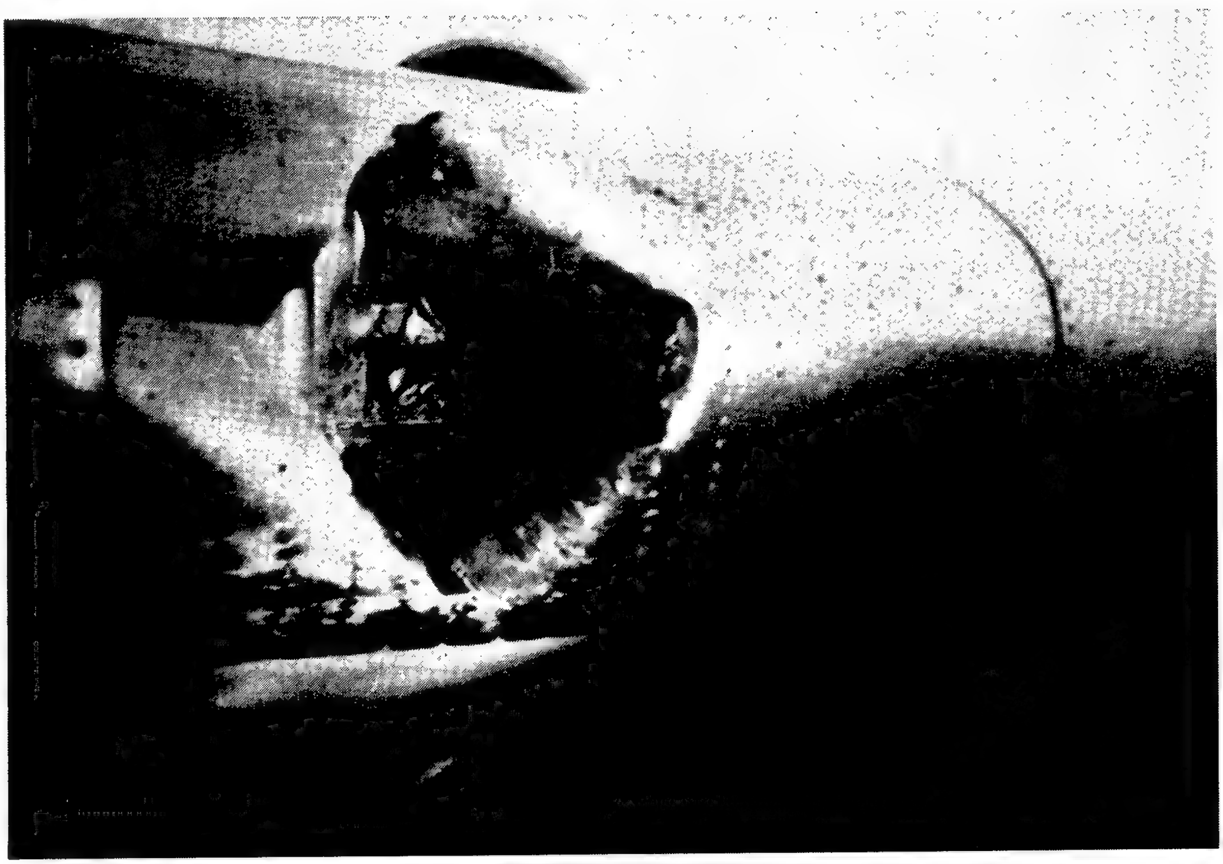


Fig. 2

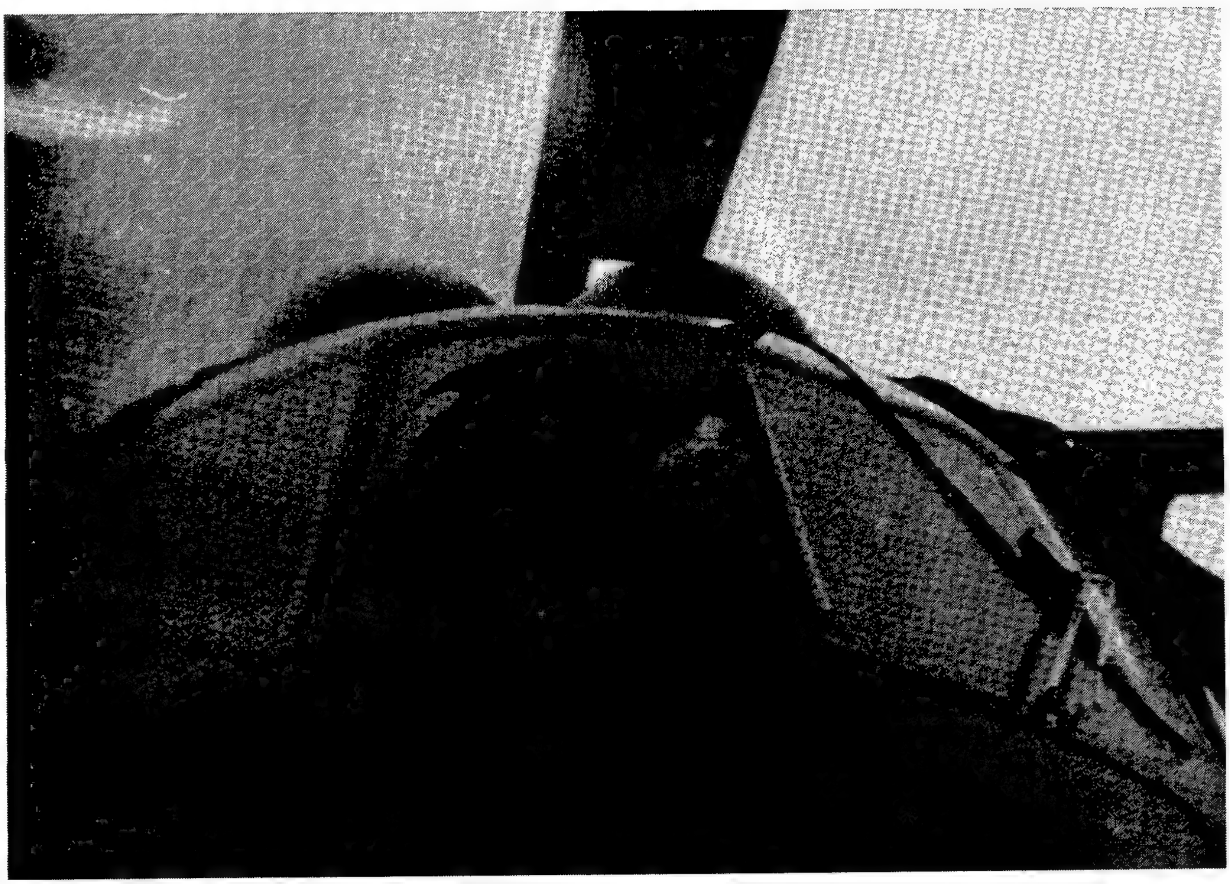


Fig. 3

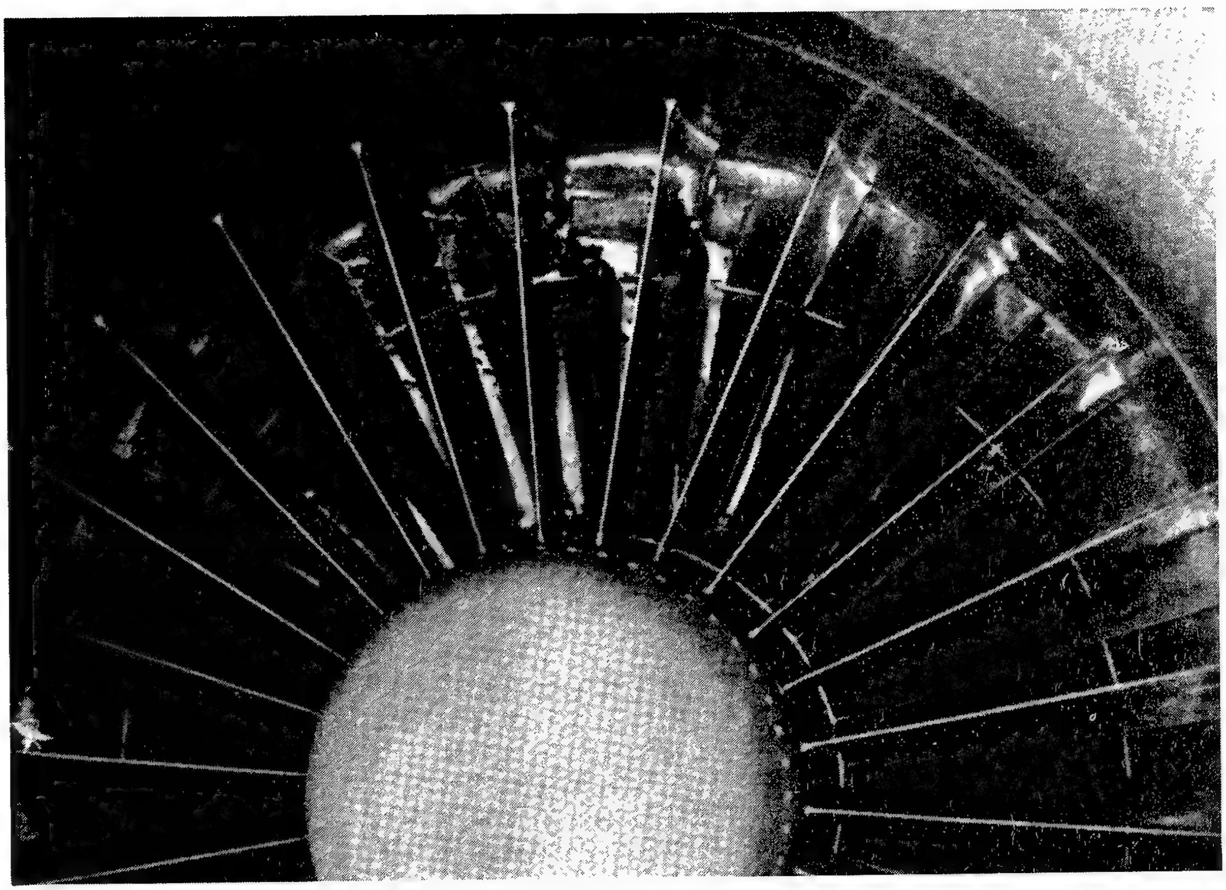


Fig. 4

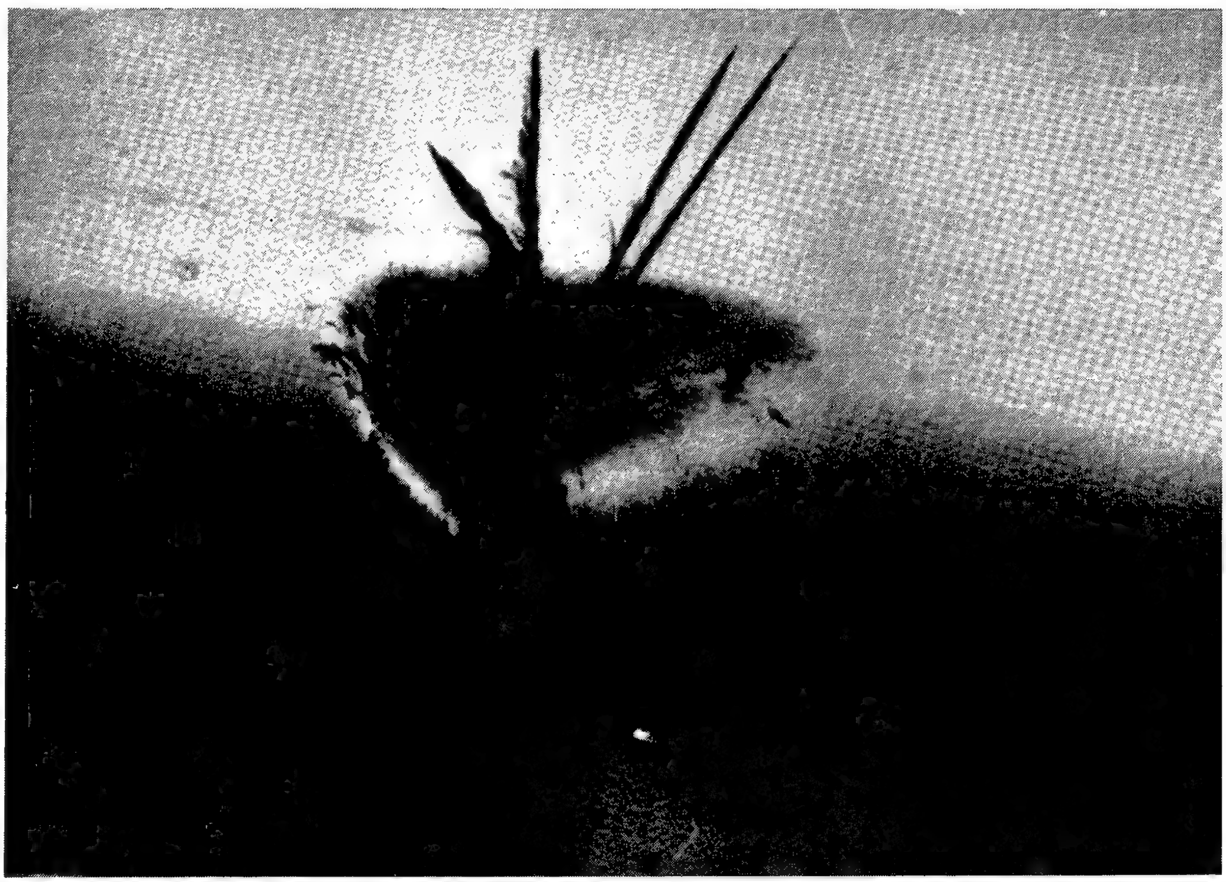


Fig. 5

ADF 616 108

About the procedures aimed at bird strike avoidance.

1. Introduction.

The arrival of subsonic jet aircraft into the commercial fleets and their rapid increase has emphasized a potent problem for a longtime taken as minor. The recent introduction of high by pass ratio engines has greatly enlarges this problem because frontal area of each engine increases more than three times at the same time that the quantity of air passing through the intake has almost trebled. The fleet of these 6500 aircraft, flying on the daily average of 8 hours, used all over the world, experience a daily significant number of strikes, some times very serious, caused by birds.

It then becomes necessary to stop this increase and if possible reduce as far as possible the number of these strikes.

More and more accurate information is collected in Europe on the behaviour of birds and on their reactions. It seems possible to forecast with an acceptable certainty their activities on and in the vicinity of airports. The problems in this field to be solved, some of them secondary, includes:

1e. Transmission, in a proper and clear language, of the information available on the airport to the real user (pilot most of time).

2e. Procedures to be recommended when the instant and accurate knowledge is available.

Those two items are briefly commented hereafter.

1. Transmission of information.

That suppose that an international agreement could be achieved on the following:

1. Definition as complete as possible of different specific cases occuring in each phase of flight.
2. Definition of the time periods most adequate for transmission of such information (periods which are improper eg on landing below 200 ft).
3. Standard vocabulary in a language usable in the various international aviation languages.
4. Definition of legal aspects covering the use of such language by the ATC.

5. Research for an automatic warning system calling the pilot attention to the immediate danger created by bird activity in the areas to be flown in the next minutes.

2. Use of this information by crews.

Two types of uses can be developed:

1 - those which can be defined as "automatic". They do not required immediate positive action from the pilot

2 - These which are needing special manoeuvres from the pilot

3.1. Actions not requiring immediate action =

3.1.1. use of landing lights = was experimented and studies by BSCE "Analysis" WG without as yet showing definitive conclusions.

3.1.2. use of various transmitters on board of aircraft (HF, VHF, radar) The impact of various permanent transmission has not been studies yet. These emissions could be experimented as were landing lights. This possibility occurs very akward and may create other problems (frequency overworked, power not available......)

3.1.3. use of special airborne transmitters. Very few trials have been made for financial reasons. One may also take into account the extra load to be carried and used only during a very short period of time.

3.2. Actions calling for special manoeuvres.

3.2.1. aircraft on ground.

3.2.1.1. take off (T.O.).

a) T.O. delayed when birds are reported or observed on the runway or in its vicinity.

b) T.O. aborted on pilot decision: the evaluation of the danger is the most delicate part of the decision process.

3.2.1.2. Landing.

After touch down, no specific action is possible, except a greater use of the brakes at the initiative of the pilot when seeing birds on the runway.

3.2.2. Aircraft in flight.

3.2.2.1. Take off/climb (up to 3000 ft).

a) Taking into account that a majority of strikes happen in the first few hundred feet during climb, a climb with a constant slope or rate of climb may be recommended. This procedure is often used in other cases such as noise abatment.

b) Other manoeuvres could not be envisaged during this phase: aircraft are very often in the lower range of their operating possibilities (outside

the margin usually taken for safety purposes).

3.2.2.2. Approach.

a) Approaches at minimum speed, and on greater slope than used but only when in good visual conditions could be studied.

b) Decelerated approaches may be discouraged.

c) Visual manoeuvres, which are possible during approaches, are left to the pilot's judgement.

d) Missed approaches may be contemplated in the case of intense bird activity reported by the tower or directly observed by the pilot.

3.2.2.3. On cruise.

a) No specific procedures can be contemplated for transport aircraft which are very seldom subject to this risk.

b) In the typical case of low flying military aircraft, special recommendations could be developed.

4. Conclusion.

Two parallels ways seems to be offered: the first one aimed to define an international vocabulary and its appropriate use, the other to tabulate specific procedures to be recommended and used.

A trial has to be carried out for both cases. This trial could only be volontary and should not be limited to one airline or a specific geographical area. Consequently it is recommended that a call be addressed to pilot, airline representatives on one side and to ATC controllers on the other side with a view to defining the conditions for such trials, schedules, and to list ways of collecting experience obtained from various individuals participating in this programme.

This collection of data could be spread over 3 years, with an interim report provided for the next BSCE meeting.

WP 32

SUMMARY OF SPRAYINGS WITH "RETA" REPELLENT AT BEN-GURION AIRPORT 1974-1979

by Shalom Su-Aretz and Ilana Agat

A. Introduction

The chemical repellent "Reta", marketed by the Assia Maabarot Co. under licence, is an Aluminium-Ammonium-Sulphate Powder of the formula $Al.NH_4(SO_4)_2$ used for spraying in water solution. "Reta" causes irritation and its taste is bitter. We have yet to find out in what way birds are deterred by it, no harmful side-effects on birds having been detected even after spraying of their food with "Reta".

At the end of 1974, Mr Giora Dar, representative of Assia Maabarot, approached the airport management with the suggestion that "Reta" be tried as a repellent. Since it had already been used as a bird repellent in agriculture, and with some success, we recommended that it be tried also at the airport. We should point out here that until the end of 1977 we were acting as advisers to the airport management on matters connected with bird strikes, and repelling operations were carried out by them, during the winter season only, in accordance with our recommendations. As from 1.1.78. all operations pertaining to bird-strike problems were taken over by the Nature Reserves Authority, in accordance with a plan worked out by the authors of this paper.

B. Aim

Our aim in trying "Reta" at the airport was to find out in what way and to what extent birds would be driven off the runways and surroundings, and to check whether they would be kept away from the garbage dumps which are situated near the airport.

C. Data on Area (see sketch)

1. Due to permanent plant control, the fringes of the main Runway 30-12 are always free from vegetation to a width of some 50 m.
2. On the fringes of the "Quiet" Runway 26-08, and Runway 21-03 (also to the width of 50 m), there is aftergrowth of cereal plants used as fodder by the farmers during the first three months of the year (until its cutting in April).
3. Beyond these wide fringes, cotton fields are cultivated for some 5 months until picking in September. The fields remain bare from the end of September until the next sowing in May.
4. At the boundaries of the airfield, along the drainage channels, are tracts of fallow land. A very wide fallow tract of about 175 acres existed to the south of Runway 30-12. This and other fallow tracts were treated over the last two years with a view to controlling vegetation, and they are now most of them fit for cotton growing.
5. To complete the picture, the existence of two garbage dumps needs to be mentioned: a small dump adjoining the northern boundary of the airfield - the Yahoud dump, which was later removed (in 1977). The second dump - the biggest in the country - is the Hiriya dump, situated about 5 km west of the airport.

D. The Birds

We have to deal with many species of birds, but first and foremost with big birds which usually occur here in large flocks, as winter visitors:-

The Black-Headed Gull - *Larus ridibundus*

These gulls are wintering here from October until March. They usually sleep on the beach, but feed in agricultural areas, and principally on the garbage dumps of Hiriya and Yahoud. In the past they frequently used to roost on or near the runways, and also in the puddles formed by the winter rains. These birds usually appear in Israel in their hundred thousands.

/.......

AD F 616 109

The Lapwing - Vanellus vanellus

These appear during the same period as the gulls, though in smaller numbers. Their numbers, however, have been increasing from year to year, and by now have reached several thousands. The main problem with lapwings is that they are present near the runways at all times, even at night, looking for food or roosting.

In addition to these two main species, there are many species of smaller birds, of which two at least are worth mentioning:-

The Collared Dove - Streptopelia decaocto
and
The Starling - Sturnus vulgaris

The repellent was also tried out by us on some of the big resident birds, mainly:-

The Partridge - Alectoris chukar, which live here in numerous flocks of several hundreds, hiding among shrubs in the uncultivated plots and in the agricultural regions beyond the fence, and coming out into the bare plots to find food (mainly cereals). They constitute a grave danger to aviation because of their low flights above the runways, especially in view of their comparatively heavy weight.

The Cattle Egret - Ardeola ibis, several thousands of which are to be found in the area, and although they are not in the habit of concentrating in great numbers near the runways, they descend in great flocks on the garbage dumps to feed, and constitute a particular danger when they leave the area in flocks, frequently crossing the runways, on the way to their permanent colony (some 6 km north of the airport).

In addition to these two species, there are many other resident birds appearing only occasionally, and in smaller numbers, such as the Spur-winged Plover - Hoplopterus spinosus; the Kestrel - Falco tinnunculus; Pigeons (mostly hybrids) - Columbae; the Palm Dove - Streptopelia senegalensis, and the Hooded Crow - Corvus cornix.

E. Work Methods

1. Our first objective was the Black-Headed Gulls which, in winter, appear in huge numbers on the garbage dumps and also on the runways. Observations showed flocks of hundreds of gulls near Runway 26-08, and also at the Yahoud dump which, at the time, was situated some 500 m east of Runway 26. Partridges, too, constituted a danger on this runway, assembling on the edges of the runway in their dozens, and crossing from time to time to the other side.

   Consequently, it was decided to concentrate spraying operations during 1974-76 on the Yahoud garbage dump and on the fringes of Runway 26-08.

2. After the Yahoud garbage dump was moved about 15 km from the airport in 1977, and having tried out other deterrent methods, we considered it worth using "Reta" against the Lapwings, whose behaviour and reactions had become more dangerous in the meantime. The concentrations of Collared Doves near Runway 30-12, too, decided us to concentrate spraying on the fringes of all the runways.
   The Black-Headed Gulls also changed their behaviour in the course of the last few years, and took to roosting right at the beginning of Runway 08, as well as in the fields in the area. We therefore applied several trial sprayings on the asphalt at the starting point of Runway 08.

3. To check up on the differences in bird behaviour following sprayings with "Reta", it was decided to leave unsprayed certain parts (which were identical to the sprayed parts) for control purposes, basing our decision as to which parts to spray on bird behaviour and on surface conditions.

/.......

F. Sprayings with "Reta" *)

1. Winter 1974-75

a) The initial spraying by helicopter was carried out on 6.2.75. on the northern fringes of Runway 26-08. Two stretches about 1000 m. long and 45 m. wide (C and . in sketch) were sprayed, leaving between them an unsprayed stretch of similar dimensions for control.

b) On the same day, spraying was also carried out on a layer of fresh garbage at the Yahoud dump, and on the northern bank of the channel adjoining it (A and B in sketch) - an area of some 12 1/2 acres serving the birds as a roosting place.

2. Winter 1975-76

a) On 27 - 28.1.76., the first spraying was carried out by light plane alongside Runway 26-08, from the north (C,D,E and E_1 in sketch) to a total length of about 3000 m., and width of 45 m.

b) On 17.2.76, the same stretches were sprayed again.

c) On 15.2.76., Yahoud dump was sprayed (B in sketch) only in the garbage area (about 5 acres).

d) From 18.2.76. until 26.3.76., mainly the fresh garbage was sprayed daily at the dump - this time by manual pressure sprayer.

In the summer of 1977-78, sprayings with "Reta" were carried out without control or observations on our part, and are therefore not included in our report.

From winter 1976-77 onwards, spraying was carried out on a more or less fixed pattern, as shown below:-

Season	Spraying Date	Runway	Site (See sketch)	Remarks
Winter 1976-77	6-7.12.76.	30-12	F	by tractor 1st spray
	11.1.77	30-12	G (whole length)	by helicopter 1st spray
		26-08	C D E H I	" "
		21-03	J K (whole leng.)	" "
	12.1.77.	30-12	F (" "	by helicopter 2nd spray
	14.2.77.	12-08	L M (on asphalt at the crossing)	by helicopter
Summer 1977	11.7.77.	30-12	G (whole length)	" "
		26-08	H I " "	" "
Winter 1977-78	19.1.78	30-12	F	" "
		26-08	D E H	" "
		21-03	J	
	30.1.78.	12-08	M N (on asphalt at the crossing)	" "

*) All sprayings were carried out in accordance with professional directives of "Assia Maabarot", with regard to quantities, concentrations and spraying periods.

/.......

... table cont'd

Season	Spraying Date	Runway	Site (See sketch)	Remarks
Winter 1978-79	2[illegible].11.78.	[illegible]-12	F	by helicopter 1st spray
		26-[illegible]	D E H	" " "
		21-03	J	" " "
	14.1.79.	30-12	[illegible]	by helicopter 2nd spray
		26-08	D E H	" " "
		21-03	J	" " "
	24.1.79.	12-08	M N (on asphalt)	by helicopter
	5.2.79.	30-12	F	by helicopter 3rd spray
		26-08	D E H	" " "

Remarks: On 25.12.78., spraying was interrupted after a flaw in the quality of the material was detected. All the same, the observations made on the sprayed sites were taken into account.

The stretches that were treated in 1977-79 were all of similar size, as under:-

D E	north of runway	26-08	1500 x 50 m
F	south " "	30-12	2950 x 50
H	" " "	26-08	1500 x 50
J	west " "	21-03	1000 x 50
M N	intersection	12-08	650 x 45
			Total about 90 acres

G. Effects of Spraying

1. Winter 1974-75. Observations at the airport commenced on 2.1.75., about one month before initial spraying on 6.2.75. Field observations were made by the airport management under the supervision of Shalom Su-Aretz.

   a) Runway 26-08 Prior to spraying, and particularly on rainy days, many birds (mainly Black-headed Gulls) were observed on both sides of the runway.
   Continuous observations on the 8 days following spraying showed:- on 7.2.75. (one day after spraying), several Lapwings and a flock of 600-700 gulls on sprayed site ! On 10.2.75. (four days after spraying), there were 150 gulls on the sprayed site again, and on 11.2.75, there were 200. On the following days (until 14.2.75.) about 10 Partridges and several Lapwings were observed feeding. There was also considerable activity of song birds on the sprayed site. On 10.2.75., there again appeared a big flock of gulls on the sprayed site, but their behaviour was much more restless than usual.

   b) Yahoud Garbage Dump Prior to spraying, There were mainly Black-Headed Gulls, usually many hundreds but on some days up to even 2000; furthermore many dozens of Starlings; about 50 Cattle Egrets, many Palm Doves; some Spur-winged Plovers, and many song birds.

   On the day of spraying (6.2.75.), Black-Headed Gulls were seen hovering over the garbage, though not coming down on it. Only a few hours later, however, 300-400 of them had already settled down on the garbage. On the same day, 30 Cattle Egrets were also seen in the sprayed area. The Starlings returned to their places on the antennae immediately after the helicopter had ceased working.

/.......

Continuous observation during 8 days after spraying, showed the following situation at Yahoud dump:-

7.2.75.	about 40 Cattle Egrets and 80 Gulls
8.2.75.	several Cattle Egrets; hundreds of Gulls
10.2.75.	50 Gulls
11.2.75.	Some Cattle Egrets, tens of Gulls, antennae full of Starlings.
13.2.75.	600-700 Gulls; a cloud of Starlings
14.2.75.	25 Cattle Egrets; tens of Gulls; very many Starlings, Bulbuls, Wagtails, Pipits, and many Palm Doves

Greater activity of Black-Headed Gulls in unsprayed areas during several days after treatment was pointed out.

Summary While the number of Gulls appears to have decreased, the fact must be stressed that this is the time of year when spring migration brings about a considerable reduction in their number generally. All the same, certain effects were discernible during the first few days, when restlessness and excited behaviour of Gulls was clearly noticeable. As to the other birds, hardly any effects could be discerned.

2. Winter 1975-76. Observations at the airport during this season were continuous.

a) Runway 26-08 After the first spraying on the northern side of runway (27-28.1.76.) no changes were observed, but after the second spraying (17.2.76.) a noticeable decrease was seen in the number of Lapwings on both sides of the runway (also on the unsprayed side), though the fact must be taken into consideration that in the meantime there had been a considerable increase in the height of the vegetation - a factor which has a bearing on the disappearance of Lapwings. Partridge behaviour, however, remained unaffected.

b) Yahoud Garbage Dump Intensive efforts were made to remove the Gulls from this dump. After spraying on 15.2.76., the Gulls definitely disappeared, and the few that reappeared later did not come down on the dump to feed. On the other hand, a steady increase of Cattle Egrets was observed. During the last spraying with "Reta" (18.2.76.) additional methods were employed, such as distress calls broadcast over the loudspeaker; gas-cannons and shot-guns (all in accordance with movement of Gulls), resulting in their complete ousting from the dump to which the Gulls did not return for nearly one month following application of these methods.

To sum up: There is no doubt that the use of additional methods as described in para. (b) above, helped in dislodging the Gulls, and that the application of "Reta" definitely had a bearing on their disappearance; yet the additional factor of Gulls' migration period starting at that time, must be borne in mind.

3. Winter 1976-77

a) Runway 30-12 Prior to first and second spraying (6-7.12.76. and 12.1.77.) there had been considerable activity of Partridges and Collared Doves along the southern edge of this runway. Activity extended over a wide area, from the bare stretches adjacent to the asphalt down to the uncultivated patches, and beyond these on to the fields situated south-west of the wind hose and to the north of it. In addition, a flock of 50 Collared Doves were seen feeding at the edge of the runway. Already 5 days after the first spraying, Partridges were again observed south of the runway, and from then onwards they were seen in the sprayed area on a number of additional occasions. After the second spraying, Partridges appeared only 9 days later. Collared Doves were first seen 15 days after the first spraying, and some were observed 4 days after the second spraying. During the next fortnight the number of Doves increased to about 50 at the same place south of the runway where they had been at the beginning of the season. No Lapwings were seen north or south of the runway, either before or after spraying.

c) Runway 21-03. Here, too, flocks of Lapwings were observed, whose behaviour after spraying (11.1.77.) was found to be similar to that observed along Runway 26-08.

d) Runway 08-12 Lapwings and Wagtails used to roost on the asphalt at the starting point of this runway prior to spraying. Some ten days after spraying they reappeared on the same stretch.

Summing-up: "Reta" was found to have a certain effect on birds, mainly Partridges and Collared Doves, though for relatively short periods only. Regarding Lapwing, restless behaviour was noticeable, apparently as a result of the "Reta" treatment.They were however not permanently repelled,but already reappeared on the day after spraying, although in smaller numbers. Song birds were not repelled at all as a result of spraying.

4. Winter 1977-78

a) Runway 30-12 Spraying was applied on Part F (see sketch). Observations during period 18.12.77. - 28.7.78. showed the following: The presence of Partridges on the sprayed side of the runway was not affected. Excitement of Collared Doves was very noticeable. Some crossed over to the unsprayed side where they had not been before. During 2 weeks after spraying, the Doves crossed the runway in a manner which was imperilling aviation. The Lapwings reappeared for the first time 3 weeks after spraying. There were no Lapwings to a distance of over 50 m north of the runway.

b) Runway 26-08 Spraying was applied on D, E and H (see sketch). Observations during period 11.12.77 - 26.2.78. showed that all Partridges which had previously been on the side of Runway 21, transferred jointly to an unsprayed place at the starting point of Runway 26 as a result of spraying operations. The Lapwings returned to their usual place in the sprayed area about one week after spraying.

c) Runway 21-03 . Spraying was applied on J (see sketch). Observations during period 11.12.77. - 23.2.78. showed that here, too, the Partridges were hardly affected, and Lapwings reappeared one week after spraying.

d) Runway 08-12 Spraying was applied on M and N (see sketch). Observations during period 3.1.78. - 23.2.78. showed no change in the behaviour of Lapwings and no noticeable effect on Black-headed Gulls.

Summing up : No change was discernible in Partridge behaviour as a result of spraying operations which were seen, however, to have a certain effect on Lapwings (though for only about one week). On the other hand, considerable change in behaviour was observed in Collared Doves, which returned to their usual place only two weeks after spraying.

5. Winter 1978-79

General We assume that the change in bird behaviour is due to the improved ecological quality of the environment, and especially to pest extermination in the uncultivated stretches of land adjacent to the runways. Partridges preferred hiding in uncultivated lands farther away from the runways. All the same, there was movement of Partridges crossing runways from one side to the other in search of food. Collared Doves, which had been present in previous years, did not reappear in their usual places at the airport. Gulls appeared on rainy days only, as in former years, and no activity was observed near runways (including unsprayed ones) either before or after spraying, but only in the ploughed fields farther away.

This year we were able to test spraying of the asphalt at the starting point of Runway 08 (24.1.79.). Two days before spraying several tens of gulls were seen roosting on the runway. Only about two weeks later, rain fell for the first time and on that day several gulls were seen roosting on the sprayed runway. No gulls whatsoever were seen at the airport between 24.1.79 and 8.2.79.

In our observations this year we took special note of the effects of spraying on Lapwings, as detailed herebelow:-

Runway 26-08

As far as behaviour of Lapwings was concerned, no change whatsoever was apparent as a result of the first spraying (29.11.78.)(D,E,H in sketch). During the second spraying (14.1.79.), which was imperfect due to technical reasons, the Lapwings started to assemble in big flocks - as is their usual habit at this season - and to leave the area under review, particularly because the vegetation there had grown to a height of over 20 cm. Nevertheless, there were two instances when some did come down on a sprayed area (H) - first, 9 days after the second spraying, and again two days after the fourth spraying (5.2.79.).

Runway 30-12

Lapwings appeared on sprayed site (F) on the day after first spraying. Here, too, no Lapwings were seen after the second and third sprayings for the same principal reasons mentioned above: height of vegetation, and birds assembling in big flocks and moving away from runways.

Runway 21-03

Lapwings appeared on the sprayed part of runway (J) two days after spraying, while none whatsoever had been seen there during the two weeks prior to spraying.

Crossing of Runways 12-08 (Asphalt)

Only one treatment was applied to the two parts (M,N) of this stretch (24.1.79.) Here, hardly any Lapwings were observed either before or after spraying, except in a few instances on rainy days (the first rainfall after spraying occurred on 8.2.79.).

It appears that Lapwings are not repelled by "Reta", seeing that there is no drastic change in their regular places after spraying. Alteration in behaviour was due to changes in weather or in surface conditions (formation of puddles after rains, height of vegetation, etc.). Moreover, we used additional deterrent methods such as gas cannons, distress calls, ultra-sonic sounds, bang pistols, and nets. They were never observed to disappear after spraying from a place in which they had stayed regularly for a fortnight before. Furthermore, there was no change in their flights above the runways, so that the danger of Lapwings to air traffic was not diminished at all.

/.......

Final Summary

Our main aim in trying out the effects of "Reta" at Ben Gurion Airport has been the removal of the big birds from its runways and adjacent areas in view of the danger to air traffic. Spraying with "Reta" alone, as well as concurrent application of other deterrents, was carried out in accordance with the instructions of "Assia Maabarot", whose representative was present during spraying operations. In spite of the high cost of "Reta", spraying was carried out over large areas (about 90 acres) which were divided into several stretches, with equivalent stretches being left untreated for control and comparison.

A considerable part of their budget (at least 40%) for the prevention of bird strikes at Ben-Gurion Airport (including labour cost) was spent by the management for spraying only on the trial areas.

Spraying operations also entailed a considerable waste of time, as results very much depended on the weather, and spraying often had to be cancelled because of wind, rain, etc. Furthermore, co-ordination with the control tower to ensure the safety of the spraying planes, caused serious problems and difficulties.

Compared with "Reta" all other methods are cheap, can be activated at short notice, require hardly any coordination with the control tower, and can be applied quickly wherever needed. Even though these methods often have only a short-term effect their results are nearly always immediately noticeable. Moreover, methods based on distress calls, ultrasonic sounds, nets, "models" etc., will act on birds in any position, including flight (a very important factor from the danger point of view) whereas "Reta" only acts on birds landing to feed or roost.

Our observations and follow-up were continued for a considerable time, before and after sprayings, and almost without interruption (especially during the last two years). In analysing the results, we did no overlook the fact that certain birds, such as the Collared Dove (in small flocks), immediately after spraying left the place where they were usually feeding, returning to it only after a fortnight. The Black-headed Gulls, too, sometimes showed"restless behaviour" after spraying, but disappeared from the Yahoud dump only once (in winter 1975-76), and this only after intensive and efficient use of all the other deterrents (distress calls, gas cannons and shot guns)in addition to "Reta".

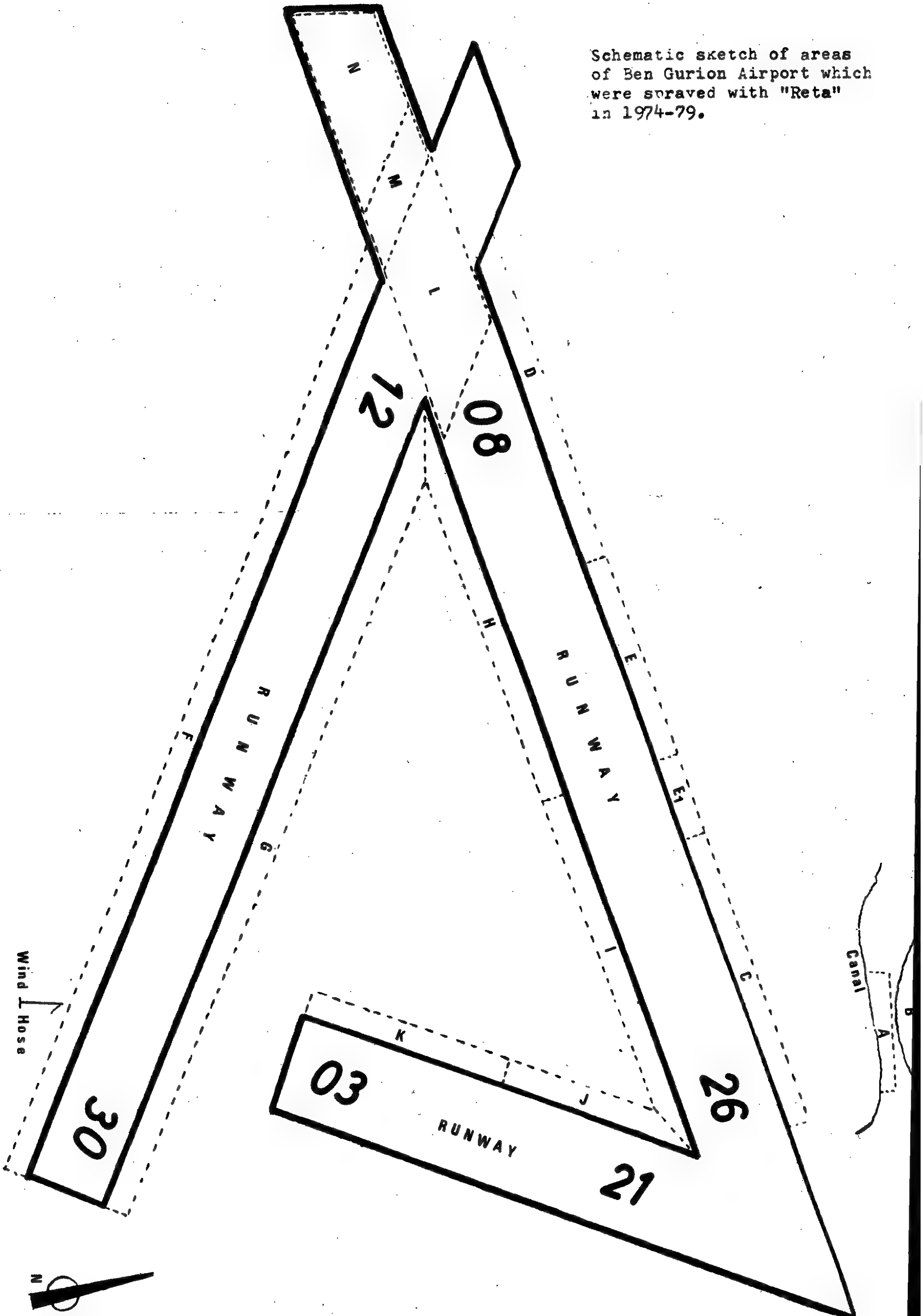
With regard to Partridges and Cattle Egrets, hardly any effect of "Reta" was registered. The Lapwings, for instance, formed flocks in their usual places, imperilling aviation also on the sprayed stretches. They actually only disappeared from places where vegetation had grown to a height of more than 20 cm, apparently without any connection whatsoever with spraying.

Reports from previous years (1973-77) showed several dozens of collisions of birds with aeroplanes during take-off or landing, and 5-6 serious ones every year when even jet engines were put out of action. As against this, there were only a few collisions in the last 2 years (1978-79) and none in which a jet engine was damaged.

There is no doubt in our minds that this success has been due to the continuous activity connected with the removal of food sources (garbage dump, vegetation control, coordination of agricultural activities, etc.) together with the efficient use of deterrents (distress calls, nets, "models", etc.) in addition to "Reta".

In spite of positive results obtained in certain cases, we are of opinion that the means invested in spraying with "Reta" are out of all proportion to the effects, and have therefore reached the definite decision to discontinue the use of "Reta" and to concentrate all our efforts on the development of alternative methods.

Schematic sketch of areas of Ben Gurion Airport which were sprayed with "Reta" in 1974-79.



AD F616 110

WP33. 14th Meeting
Bird Strike Committee Europe
22-26 October, 1979
The Hague, Netherlands.

BIRD CONTROL AT HELSINKI-VANTAA AIRPORT, FINLAND

Seppo Kuusela[1] and Olavi Stenman[2]

This paper provides preliminary information about bird control measures taken in 1978-79 at Helsinki-Vantaa Airport, Finland.

1) Helsinki-Vantaa Airport, P.O. Box 22, SF-01531 Helsinki-Vantaa-Lento.
2) Finnish Game and Fisheries Research Institute, Game Division, Unionink. 45 B, 00170 Helsinki.

Introduction

Compared with many other European countries birds have presented few problems to air traffic in Finland. Three or four of the 87 bird strikes reported in 1970-78 had a serious effect on the aircraft. Most of these incidents occurred at the main international airport, Helsinki-Vantaa. In the 1970s, 2-5 incidents were reported here yearly. These involved the following species: herring gull, black-headed gull, black grouse, and starling. In addition to these species, more than 30 other species are considered to pose a potential hazard to air traffic. The two most serious incidents to date happened in 1978. On June 11th and July 22nd, a DC-8 and a Caravelle, respectively, were damaged by gulls. The damage cost approx. U.S. $ 250 000 to repair.

Control

Before these two serious incidents The Finnish National Board of Aviation had set up a working group to plan a bird control programme. Quite naturally, however, bird control at Helsinki-Vantaa Airport was stepped up considerably as a result of the incidents. The following measures were taken:

1) A bird strike committee was established at the airport on January 9th, 1979, consisting of 10 persons representing:
   - Airport Authority Traffic Manager
   - Air Traffic Control
   - Fire Department
   - Traffic Area Maintenance
   - Finnair Flight Department
   - ornithological experts (the Zoological Museum of the University of Helsinki and the Game Division of the Finnish Game and Fisheries Research Institute).

   The committee has had meetings at 1 to 2 month intervals. It has also sent a representative to airports in Sweden and Denmark to get information about the local bird control systems.

2) Car patrolling was made regular after the first serious incident. A shotgun with either live or blank ammunition is used. The airport has a permission to shoot protected birds if necessary.
3) Measures were taken to make the airport environment unattractive to birds (as well as to white-tailed deer and moose) by thinning the forests, filling in ponds and keeping the grass relatively high (15 to 30 cm).
4) Co-operation with other authorities has been improved. The committee has tried to influence the use of land area in the airport vicinity by issuing statements and taking part in negotiations. This mainly concerns the management of the dump situated 4 km north-west of the airport and the running of the two fur farms (one of which is 2 km and the other 6.5 km from the airport).
5) Some of the dispersal methods used abroad (herring gull distress calls, leaving dead gulls near the runway) have been tested.
6) Co-operation with the hunting clubs in the airport vicinity has been stepped up.
7) An ornithological study at the airport and its surroundings was started in spring 1979. The field study is carried out by a full time ornithologist.
8) In the Helsinki archipelago, herring gull eggs were sterilized more effectively than in the previous spring.
9) In addition, adult herring gulls on the largest garbage dump in the Helsinki region were trapped and killed after their breeding season.

Results and conclusions

In 1978, more than 1000 herring and black-headed gulls were shot at the airport. The number for this year is smaller, because the gulls tend to avoid the airport area. In addition to shooting, other dispersal methods have been adopted. Blank ammunition used in shotguns has proved to be an efficent method of driving off birds. Over 90 per cent of the herring gull reproduction in the Helsinki archipelago (where there are approx. 6500 breeding pairs) has been prevented by sterilizing the eggs. On the dump, 1500 herring gulls have been caught with gull traps; however, the ringed individuals were released. On the other hand, poisoning (e.g. by alphachloralose) has not yet been considered an appropriate means of control.

The measures taken have clearly improved the situation. In summer 1979 the bird activity was noticeably less heavy than in the previous summer at Helsinki-Vantaa Airport. However, maintaining an acceptable level of safety at the airport requires the continuation and development of bird control measures. It is also very important to continue long-range schemes for making the airport and its surroundings as unattractive to birds as possible.

TERMS OF REFERENCE.

Terms of reference of the BSCE

The Bird Strike Committee Europe shall:

a) collect, analyse and cirkulate to all concerned data and information related to the bird strike problem in the European Region;

Note: This data and information should include the following:

1. Civil and or military data collections and results of analyses on bird strikes to aircraft.

2. Results of any studies or examinations undertaken by states in the various fields related to the bird problem.

3. Any information available in the field of design and structural testing of airframes related to their resistance to birdstrikes.

4. Any other information having a bearing on the bird strike question and the adding to the solution of the various problems involved.

b) study and develop methods to control the presence of birds on and near aerodromes;

c) investigate electro-magnetic wave sensing methods (e.g. radar, invisible light etc) for observing bird movements;

d) develop procedures for the timely warning of pilots concerned where the existence of a bird hazard has positively been established;

e) develop procedures, if appropriate, for the initiation by air traffic control of avoiding action where existence of a bird hazard has positively been established;

f) develop procedures enabling a quick and reliable exchange of messages regarding bird hazard warnings;

g) develop any material (e.g. maps, back-ground information etc) intended for inclusion in Aeronautical Information Publications;

h) aim at a uniform application, throughout the European Region, of the methods and procedures and the use of material developed in accordance with b) to g) above, provided suitable trials have proved their feasibility, and monitor developments in this respect.

Terms of reference of the Editing Committee BSCE

1. An Editing Committee is appointed as a policy steering committee to assist the chairman of the BSCE between and during meetings. The main tasks of the Editing Committee are:

   a) To study, evaluate and select papers to be presented to the working groups and the Plenary meeting,

   b) To participate during each BSCE Meeting in preparing recommendations, proposals for text for inclusion in the Report, and, where necessary, any other paper of a general nature,

   c) To participate at the end of each BSCE Meeting in preparing the Report of the meeting and to prepare the follow-up action of recommendations,

   d) To assist the BSCE chairman in formulating BSCE Policy Statements.

2. The Editing Committee should consist of:

   (i) The BSCE chairman and vice chairman

   (ii) The previous BSCE chairman, if possible

   (iii) The Chairman of each BSCE working group

   (iv) The observer from ICAO

   (v) A representative of the host state.

3. The conclusions of the Editing Committee should be presented to the Plenary meeting of the BSCE for action. Alternatively the members of the BSCE should be kept informed of the activity of the Editing Committee between full meetings of the BSCE.

4. The BSCE chairman acts also as the chairman of this committee and is entitled to call meetings of the Editing Committee as and when required during BSCE meetings.

Terms of office of the chairman

5. The chairman is elected by the Committee for a term covering two periods between meetings, that is three years.

Terms of reference of the vice chairman

Responsibilities:

1. To assist the chairman to carry out the work of BSCE.

2. To take over the responsibilities of the chairman in the event of the chairman being unable to carry them out.

3. To represent BSCE when so designated by the chairman.

Terms of office of the vice chairman

4. The vice chairman is designated by the hosting nation for the next meeting within 30 days after the completion of the previous meeting. The vice chairman shall then serve for 18 months until and including the meeting in his/her country.

MINUTES OF THE PLENARY MEETING.

Bird Strike Committee Europe

Minutes of the Plenary Meeting, 26 October 1979

1. The meeting was opened by the acting chairman, Colonel E P Schneider of Denmark.

2. Presentation of papers

   a) V E Ferry presented shortly his paper: "The first ten years of BSCE" (WP 3) which contains a short history of BSCE 1966-1975, gives a complete list of lectures during that period (about 115) and also contains a list of recommendations agreed upon at the first meeting of the Committee.

   b) L-O Turesson summarized his paper "Code of Practice of BSCE" (WP 5) and presented it by the aid of a few over head slides. The document starts with a background to and a brief history of BSCE. The main content is a description of the organization and way of working of the Committee and its working groups. Originally this work started up due to a wish from ECAC to become better informed about the activities of BSCE and the aim of the document is therefore to explain what the Committee is doing and how it works

After the presentation there was a short discussion about the possible use of a Code of Practice and the size of it.

G Capsey, ECAC, said that the content was in the right lines to ECAC but he recommended a division of the document into two parts, one main section with the history, way of working and achievements and a second section with appendices giving all types of details for those who want to have that material. - He also said that if any further proposals or recommendations of interest for ECAC would come up at the meeting, ECAC could consider these matters together with its 22 memberstates, "ECAC is always receptive for BSCE proposals".

3. Reports by the chairmen of the working groups.

3.1 W.G. Aerodrome

In the absence of the chairman, K Pedersen of Denmark, the chairman's report of the activities of W G Aerodrome was read by H Dahl, Denmark, vice chairman of the group. - All

reports by the chairmen of the working groups are found in section 3 of the main report from BSCE 14.

After the presentation of the report some discussion started about the content of paragraph 6.

J Seubert had the opinion that the content of paragraph 6 did not entirely reflect what was said in the meeting of the working group. After comments by H Dahl and others a proposal with a new reading of the second passage of paragraph 6 (a compromise in relation to different views) was put forward by J Thorpe. The proposal was approved and it reads as follows:

"After considerable discussions it was agreed that when visiting other countries to provide advice on bird control measures on civil aerodromes, the ICAO Regional Office, the appropriate National Authorities and BSCE should be informed. In this connection the good results achieved by the advisory group meeting in Bangkok 1978 were mentioned".

There were no recommendations for future work proposed by W G aerodrome. - All recommendations based on the activities of working groups or assigned by the Committee to the W G:s are contained into section 7.

3.2 W.G. Analysis

The chairman's report of the activities of working group Analysis was read by J Thorpe, UK, chairman of the group.

Immediately after the presentation Thorpe made a complementary addition to the table in paragraph 5.3 following information received by the representative of Portugal, J Santos.

Seubert asked if the bulletins of "Serious bird strike incidents to civil aircraft" prepared and issued by the chairman of W G Analysis were also distributed to the airlines.

Thorpe answered that they were distributed only to the Association of European airlines, the chairmen of national committees and to personal doing the national analysis. He said that it was not possible for him to distribute hundreds of copies.

Gauthreaux: Will these reports on serious incidents be published as a part ot the proceedings?

Thorpe: They could be published as an appendix to the paper on civil analysis.

Hild asked about the content of paragraph 5.10 which stated how to refer a birdstrike in relation to areas inside or outside an airport. He had a suggestion that 200 ft and not 500 ft should be the upper limit for approaching aircraft when birdstrikes inside an airport were counted.

Thorpe answered that this question had become the matter for a long discussion at the meeting of the working group but it had not been possible to reach any definition. Preliminary it had been agreed that bird strikes occuring below 500 ft at an aerodrome would be included in the total for that aerodrome, whilst between 500 and 2500 ft they would be considered as being near that aerodrome.

Trunov informed that he intended to prepare in a near future a list with correct names of birds in Russian. He also asked to whom he had to send that list. van Wessum said that this material could be put into the proceedings and therefore preferably sent to him.

Recommendations:

Three recommendations proposed by the working group were approved by the Committee.

On the proposal of Harrison a fourth recommendation concerning distribution of bird strike reports to the ICAO regional offices was also approved. On the proposal of Thorpe it was further decided that an earlier recommendation concerning the ICAO definition of a Bird Strike should still be valid.

Wilde announced here that the distribution of material to the ICAO regional offices could certainly be done from the headquarters with effect from the time when the planned bird strike data base was operating.

After the approvement of the recommendations there was a further discussion on the subject of item 5.10 in the report.

Boomans suggested that the hight of 500 ft should be used also for military purpose.

After consultation of Kingston, UK, who is responsible for the military BSCE statistics, it was decided that 500 ft should be used as an upper limit also for military birdstrikes at airports.

3.3 W.G. Bird movement

The chairman's report of the activities of working group Bird movement was read by J Hild, Federal Republic of Germany, chairman of the group. Three recommendations concerning the new maps for bird migration and bird concentration areas were proposed and also approved by the Committee.

3.4 W.G. Communication and flight procedures

The chairman's report of the activities of working group Communication and flight procedures was read by V E Ferry, France, chairman of the group.

Van Geuns proposed an amendment of paragraph 6 of the report so that it had to be read in the following way:

"Evaluation will be taken up of the proposal for warning pilots about the presence of birds including consultation of the proper authorities.....". The amendment was adopted.

The group had proposed two recommendations. No 1 of them was passed by the meeting without any modifications but No 2 got a changed wording after suggestions from J Thorpe and others. That recommendation will now read as follows:

"That ample and proper warning be given about operational restrictions on the use of runways imposed by the danger created by bird activities."

3.5 W.G. Radar

The chairman's report of the activities of working group Radar was read by B Bruderer, Switzerland, chairman of the group. The report was approved. After a remark from Dallo that the contents of the two clauses of paragraph 7, dealing with recommendations, were contradictory, the meeting decided that the recommendations from BSCE 13 should still be valid. The content of this recommendation deals with the improvement of the "collaboration in bird migration research in Europe".

Ferry expressed an opinion that the title of the working group should be expanded for the reason that the work now covered not only radar but also sodar and equipments for image intensification as well as for infrared viewing. He suggested a new name: "Radar and electronic devices". After some discussion the name was confirmed to be: "Radar and other sensors".

3.6 W.G. Structural testing of airframes

In the absence of the chairman, P F Richards of UK, the activities of W.G. Structural testing of airframes was read by W E Wester, Federal republic of Germany.

Following the presentation of the report there was some discussion about the content. Harrison gave the information about the text of paragraph 3.1 of the report that IATA was not involved in the activities mentioned there. It was also uncertain, he said, if the results of possible testings should be released to airframe manufacturers and industry groups outside the U.S. However, they should certainly be distributed to BSCE. - It was decided that the name IATA be deleted from the text.

Thorpe asked if it was known why the American engine manufacturers did not come to BSCE 14 though they had been invited a long time in advance.

Turesson said that an answer had been received from Pratt & Whitney saying that they "due to many other pressures in the engineering programs were unable to accept the kind invitation".

A small amendment of the text of 3.3 was also made on the proposal of Ferry. The first sentence of the second passage was transferred to the end of the first passage.

Four recommendations, two repeated from BSCE 13 and two new ones, were approved by the meeting.

4. Co-operation with ICAO

4.1 Analysis of strike reports

Thorpe reported about this item and indicated two special points to pay attention to when working with bird strike reports and the distribution of them

a) Too much work is often done by people preparing the BSCE analysis through including unnecessary information. Just deliver parameters that are asked for in the forms which are now valid.

b) Exchange of information on bird strikes often takes a very long time. This can be avoided if the reports are sent to the national representatives for BSCE working group Analysis in each country. Thorpe promised to cirkulate a list with names of these representatives.

Bruderer asked if it will be necessary in the future to give information about the weather and use of lights. He referred to the paper of professor Verheyen and the discussion after the presentation of it.

Thorpe answered that even though the uncertainty is great here it would be better to include this information.

4.2 ICAO workshops on bird hazards to aircraft

Turesson informed of the present situation about future workshops on bird hazards to aircraft which will be arranged by ICAO. One workshop was held in Bangkok 1978 and the next one is planned for Dakar, March 1980. Tentatively are also planned similar workshops for the Middle East region in 1981 and for the South and Central America regions in 1982. BSCE will support those arrangements as much as possible.

4.3 Updating of the Airport Services Manual, Part 3 "Bird Control and Reduction"

According to the ICAO programme for updating of manuals an amendment of the above mentioned manual is planned to be performed during 1980 or 1981. Turesson said that BSCE is willing to help with this task in the same way

as the committee did with the first amendment in 1977.

Thorpe asked for help with a planned amplification of the list with bird names that belongs to this manual as appendix 1. Such an addition to the list should also be desirable or necessary for the programme of the ICAO project with a computer data base for the analysis of bird strikes.

4.4 Updating of ICAO Annex 14, paragraph 9.3 "Bird hazard reduction"

In his working paper to BSCE 14 Wilde asked on behalf of ICAO for help with an improvement and enlargement of the specifications for control of birds at airports that are contained in the ICAO Annex 14, paragraph 9.3. Turesson informed that the BSCE Editing Committee at a meeting had declared the willingness of the committee to give help with this task.

4.5 Other co-operation with ICAO

Ferry presented the views of BSCE on some other ways of co-operation with ICAO. He mentioned that the ICAO Aerodrome Manual Part 5, volume II, which has a chapter dealing with "Bird Hazard Reduction", also needs a revision. Another important matter to be handled in the future is to develop a vocabulary to be used in the communication on bird risks between air traffic controllers and pilots. In an abbreviated form Ferry also gave his views on the content of items 4.1 and 4.2.

5. Co-operation with other international organizations in the field of aviation

Ferry gave an overview of the present relationship between BSCE and some international organizations of interest for its work. The ties with IFALPA through some pilots working also for BSCE were mentioned as well as signs of an improved co-operation with IATA through its European office (in Geneva). The contacts with ECAC were described as faithful and very promising; no doors are closed!

6. Recommendations to be assigned by the Committee to the working groups

Turesson presented this item and said that the Editing Committee had proposed that all recommendations assigned to the working groups at BSCE 13 should still be valid with one exeption, recommendation No 2 to W.G. Analysis. This proposal was approved by the meeting.

On the proposal of Wilde the meeting also decided to assign the task with updating of ICAO Annex 14, paragraph 9.3 to working group Aerodrome.

Turesson delivered a proposal from the Editing Committee about a general recommendation dealing with the planning of future BSCE meetings in order to facilitate the work of the working groups. The recommendation was formulated in the following way:

"In letters of invitation to future meetings of BSCE a special request should be made to those applying for participation if they are willing to work actively for one or more of the working groups of the Committee."

The recommendation was adopted.

Finally there was a small discussion about recommendation No 1 to W.G. Aerodromes. Dahl declared that the working group had suggested that the content of this sentence should not be looked upon as a proper recommendation but as a statement. This also became the decision of the meeting.

7. EEC Council directive on bird conservation. Possible recommendations

Ferry, who has been working with the matter of the EEC Council directive on bird conservation since the problem was brought up about three years ago, informed about the actual situation. The directive had been published in the "Official Journal of the European Communities" on 25 April 1979 and will become applicable on 2 April 1981 for the 9 member states. Ferry also drew the attention to working paper No 30 from BSCE 13 (Dallo) which describes the ways of working of the international organizations of interest for BSCE. About EEC was to say that once a directive has been published it will be in force in all member states from a fixed date.

The content of those articles of the directive that are of main interest was described. This information included article 9, which gives the possibilities of derogations from the regulations of earlier articles but also stresses the necessity of reporting anually to EEC about all types of derogation activities. Possible future difficulties with this type of reports was highlighted.

The presentation ended with the reading of proposals for two recommendations according to the following:

No 1

Whereas the E.E.C. directive on the conservation of wild birds (79/409/EEC) and especially article 9 § 3,

the Committee recommends that

Member States of the E.E.C. participating to the work of the Bird Strike Committee Europe will send to the Committee a copy of their annual report to the Commission of the E.E.C.

No 2

Whereas the E.E.C. directive on the conservation of wild birds (79/409/EEC) and especially article 9 § 4.

the Committee decides

to send a letter to the Commission of the E.E.C. in order to be kept informed of the decisions the Commission may take, if and when incompability between the provisions of the directive and national measures taken in the interests of air safety is proved.

The recommendations were approved but there was also a short discussion concerning the content of them. Brough pointed out that bird control on airfield is not likely to become easier through the EEC directive so the activities of recommendation No 2 will certainly be one valuable mean for the furtherance of a good bird control. It's important to get through information of our problems to Brussels. Brough was also uncertain about the possibilities to distribute copies to BSCE of the national reports to EEC.

Ferry had the opinion that the two years which are still left until the date when the EEC directive is in force must be used to facilitate the future changed situation by mutual information BSCE/EEC and also by information to EEC from the member states.

Thorpe underlined the necessity to give best possible information to EEC about the problems caused to the bird control work by the new directive. He suggested films to be used or perhaps the material of the working paper of captain Bakker of the Netherlands.

8. Other matters. Possible recommendations

Ferry proposed that BSCE should have some type of award or citation for those who have done a work of high significance and importance for the Committee and have therefore deserved a special encouragement. Such a citation could be distributed for the activities during every 18 months period between two BSCE meetings.

The chairman said that he was in favour of such an idea and Ferry added that the origin of this idea came from Seubert who had suggested for the flight insurance companies that talks could be held to the pilots reminding them of their responsibility for the avoiding of bird strikes.

The meeting decided to introduce a BSCE award according to the proposal of Ferry. The distinction should be called the "Mike Kuhring Award" in order to memorize the pioneering work of the late professor Kuhring with the bird problems of aviation.

Ferry also proposed that the first award should be given to Hans Dahl, chairman of working group Aerodromes who has carried out an important work for his group, specially with the preparation of a booklet summarizing "measures used in different countries for reduction of bird strike risk around the airport". - The meeting agreed to give the first award to Dahl and he was given a loud applause. Dahl expressed his gratitude for the honour that had been shown to him. He said that a citation of this type was also giving him an obligation to go on with the work in the best possible way.

9. Elections

9.1 Adoptions of rules for elections including electorial periods for positions of trust.

9.2 Election of chairman

The electoral periods had until now been two years for the election of chairman and vice chairman. The length of the periods had now to be changed because the period between two consecutive BSCE meetings has been changed from on year to 1.5 year (18 months). It was decided to change the length of the electorial periods to cover two periods between meetings, which means three years. This meant that the present chairman, L-O Turesson of Sweden, should remain in his position until next meeting.

9.3 Election of vice chairman

As the Committee since BSCE 13 had not had any vice chairman it was now prooved necessary to elect a vice chairman. It had not been possible before the beginning of the meeting to get any proposal about the vice chairmanship so the acting chairman now proposed that somebody from Belgium, the host country for next BSCE meeting, could take up the position as vice chairman of the Committee. Representatives for Belgium said that they had been discussing the possibility of suggesting a Belgian military person for the vice chairmanship but he was not present at the meeting and had not been asked about his willingness to take up that work. It was proposed that a letter be sent to this man asking him if he was available for the task as vice chairman at BSCE.

Larsson expressed the opinion that an election of vice chairman should be done during the meeting as it would be difficult to arrange everything afterwards. That procedure had been tried at BSCE 13 but without result. Larsson and some other people liked to see a clever french speaking lady from Southern Europe as vice chairman so he proposed Elisabeth Dallo for that position. The proposal was applauded. Dallo declared that she had to ask her director general if she was allowed to candidate for the vice chairmanship.

In this situation the plenary meeting was adjourned for a short meeting with the Editing committee. At this meeting Harrison, who was permitted to take part in the discussion even if not a member of the Editing committee, suggested a

counterproposal which he afterwards also addressed to the main meeting. The content of the new proposal was as follows:

"The rules of the BSCE should be changed so that the vice chairman shall serve for one meeting and be designated by the hosting nation within 30 days after the completion of the previous meeting. The vice chairman shall then serve for 18 months until and including the meeting in his/her country."

This proposal was approved and also applauded by the audience.

10. Planning for BSCE 15 and 16

Turesson informed that the long term planning of BSCE meeting had already 1978 included a meeting in Belgium in the spring of 1981 (BSCE 15). The final authorization for the "Administration d l'Aéronautique" to organize BSCE 15 had been given in May 1979. A meeting with Belgian participants of BSCE had been held one of the last days and it was there agreed about the way to start up the planning procedures.

About BSCE 16 Turesson said that after initiatives by Ferry and Jacoby preliminary contacts had been taken between BSCE and the organizing committee for the 18th International Ornithological Congress which will be held in Moscow, August 1982. The idea of BSCE is that an international symposium including the bird problems of aviation could be a part of the ornithological congress and BSCE 16 be held in connection with (before or after) the big event. The president of the congress (XVIII Congressus Internationalis Ornithologicus), professor L von Haartman of Helsinki, is positive to this idea.

After the information by the BSCE chairman on the planning of future meetings there was some discussion.

Thorpe expressed his doubts about the usefulness of another world conference on the bird problems of aviation so close to the previous one (held in Paris, October 1977) especially in a place where it might be difficult for some people to travel to. He also meant that the ICAO regional workshops now almost fulfilled the purposes of worldwide conferences.

Schneider made a remark that the spacing between worldconferences in this way should be of the size of about 5 years and thereafter Turesson completed his statement by saying that it was a wish of BSCE to get in closer contact with the ornithologists and this seemed to be a good occasion. Next similar opportunity could not be expected to turn up until 1986.

Seubert said that in his opinion it is easier for some groups of people interested in the bird problems of aviation to go to a BSCE meeting than to a world wide conference.

The chairman asked for the opinion of the USSR delegation on this matter and got the reply that a world conference seemed to be better.

Tengeler had the same view as Thorpe about the perhaps reduced possibilities for some people to travel to Moscow.

The chairman made a conclusion of the discussion suggesting that the planning for BSCE 16 should follow the broad outlines laid down by the chairman of BSCE. This statement was also approved by the meeting.

11. Termination of the meeting

As chairman of the meeting Schneider expressed his thanks to the audience for good behaviour and help with the leadership.

Turesson delivered, as chairman of BSCE, a speech of gratitude to the organizers of BSCE 14. He mentioned here the Ministry of Transport and Public works and its Civil Aviation Department, the Schiphol airport management and the organizing committee headed by van Wessum. Everything in the meeting was said to have been so well organized and fitting so well in the programme. - After the speech there was a loud applause for the organizers of the meeting.

Van Wessum expressed his thanks to the audience and said that the meeting had been a very pleasant experience for the organizers.

The meeting was then terminated.

RECOMMENDATIONS.

Recommendations for the work of Bird Strike Committee Europe and its working groups

I Recommendations based on the work of the working groups

A. Based on the work of Analysis working group

1. The ICAO work on the establishment of an International Bird Strike Data base was endorsed.

2. That the usefulness of even very small parts of feathers in identifying bird species be emphasised to pilots, maintenance personnel etc, particularly when damage occurs. Photographs were thought to be an important way of doing this. International co-operation is necessary where engines are repaired in another country.

3. That bird strikes to aircraft from another country be sent annually to the appropriate person in the country of register by 31st January, in order that these may be included in that country's analysis.

4. That bird strike reports which are received in nations without the same type of organization as in the BSCE member states, be sent to ICAO for further distribution to its regional offices and to states concerned.

5. The definition of a bird strike according to ICAO State Letter AN 3/32-71/150 of 28 October 1971 would still be used:

"A bird encounter is considered a confirmed bird strike if it leaves, on the aircraft concerned, a trace of bird impact, or ingestion into the engine, and this either.

a) in the form of damage to the aircraft; or

b) where no damage occurs, a blood smear or bird tissue or feathers visible somewhere on the aircraft."

(Note. The above unfortunately omits impacts felt by aircrew or seen by ground personnel and bird carcasses with impact evidence found on aerodromes.)

B. Based on the work of Bird Movement working group

1. The new map should be used as an informal map for civil aviation and as a planning map for military aviation.

2. The new map should be used together with birdtam and forecasts as an advisory background.

3. Further data about bird concentrations and bird migration be collected by each country and sent to the chairman in order to enable a new edition of the now existing map.

C. Based on the work of Communication and Flight procedures working group

1. That an experimental investigation be conducted in Europe in order to evaluate the possibilities and implications of special procedures developed to avoid bird strikes.

2. That ample and proper warning be given about operational restrictions on the use of runways imposed by the danger created by bird activities.

D. Based on the work of Radar and other sensors working group

1. The committee confirms recommendation C1/BSCE 12 and emphasizes the need to improve the active collaboration in bird migration research in Europe. The Committee also recommends that in addition to the radar chain along the Alps, a second chain should be established throughout the North Sea area, if technically possible

E. Based on the work of Structural Testing of Airframes working group

1. That the attention of pilots and operators should be continued to be drawn to the deterioration in bird impact resistance of windscreens which rely on the maintenance of an optimum temperature for strength if,

   - insufficient time is given for warming up the windscreen before take-off, or

   - the temperature is too high because the aircraft has been parked in the sun.

2. That, in support of (i) and (iv) of the terms of reference, members should supply to the Chairman of the Working Group,

   (a) results of any bird impact structural testing together with geometric details which have been completed by their organizations.

   (b) details of any future testing programme by their organizations.

3. That, in support of (ii) and (iii) of the term of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

4. The Analysis and Structural Testing Working Groups recognize the need for adequate information on the spatial distribution of birds within and between flocks to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike structural requirements.

II Recommendations assigned by the Committee to the working groups

A. Working group Aerodrome

1. Advise ICAO on new specifikations for Annex 14 related to the bird hazard problem (paragraph 9.3).

B. Working group Analysis

1. Previous recommendations from BSCE 12 on cost and on serious incidents are still valid.

C. Working group "Bird Movement"

1. Review the existing combined bird strike maps provided by the different countries according to the following list of criteria:

   a) Scale 1:2000000

   b) Indications of high risk areas (black) and medium risk areas (hatched)

   c) No additional information about risk periods, migration routes, risk heights

   d) The legend should remark that black/hatched areas are areas with a risk all over the year and in flight levels up to 2000 ft (GND)

   e) More detailed information should be taken out of the AIP and/or special national maps

D. Working group "Communications and Flight Procedures"

1. That with due consideration of the task involved in selecting avoidance procedures, the group should rely on the expertise of duly appointed representatives of IFALPA, IFATCA and WEAA.

2. That the future activities of the group should be aimed, as a prime objective, to the preparation of a booklet recording the national practices and offering a suggested standardized format.

3. That an investigation of possible avoidance flight procedures be conducted by the group and the results of data obtained from countries or organizations should be stated on a working paper for discussion during the next meeting.

E. Working group "Structural Testing of Airframe"

1. That, in support of the BSCE terms of reference, members should supply to the Chairman of the Working Group,

   a) results of any bird impact structural testing together with geometric details which have been completed by their organizations.

b) details of any future testing programmes by their organizations.

2. That, in support of the BSCE terms of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience which have been done by their organizations.

3. That the Analysis Working Group be reminded of the need for adequate information on the spatial distribution of birds within a flock for the large bird size to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike structural requirements.

4. The Analysis and Structural Testing Working Group recognise the need for adequate information on the spatial distribution of birds within and between flocks to enable a check to be made on the assumption that multiple bird strikes can be considered to be covered by the present single bird strike structural requirements.

III General recommendations for the work of BSCE

A. Concerning planning of meetings

1. In letters of invitation to future meetings of BSCE a special request should be made to those applying for participation if they are willing to work actively for one or more of the working groups of the Committee.

B. Concerning co-operation with EEC

1. Whereas the EEC directive on the conservation of wild birds (79/409/EEC) and especially article 9 § 3,

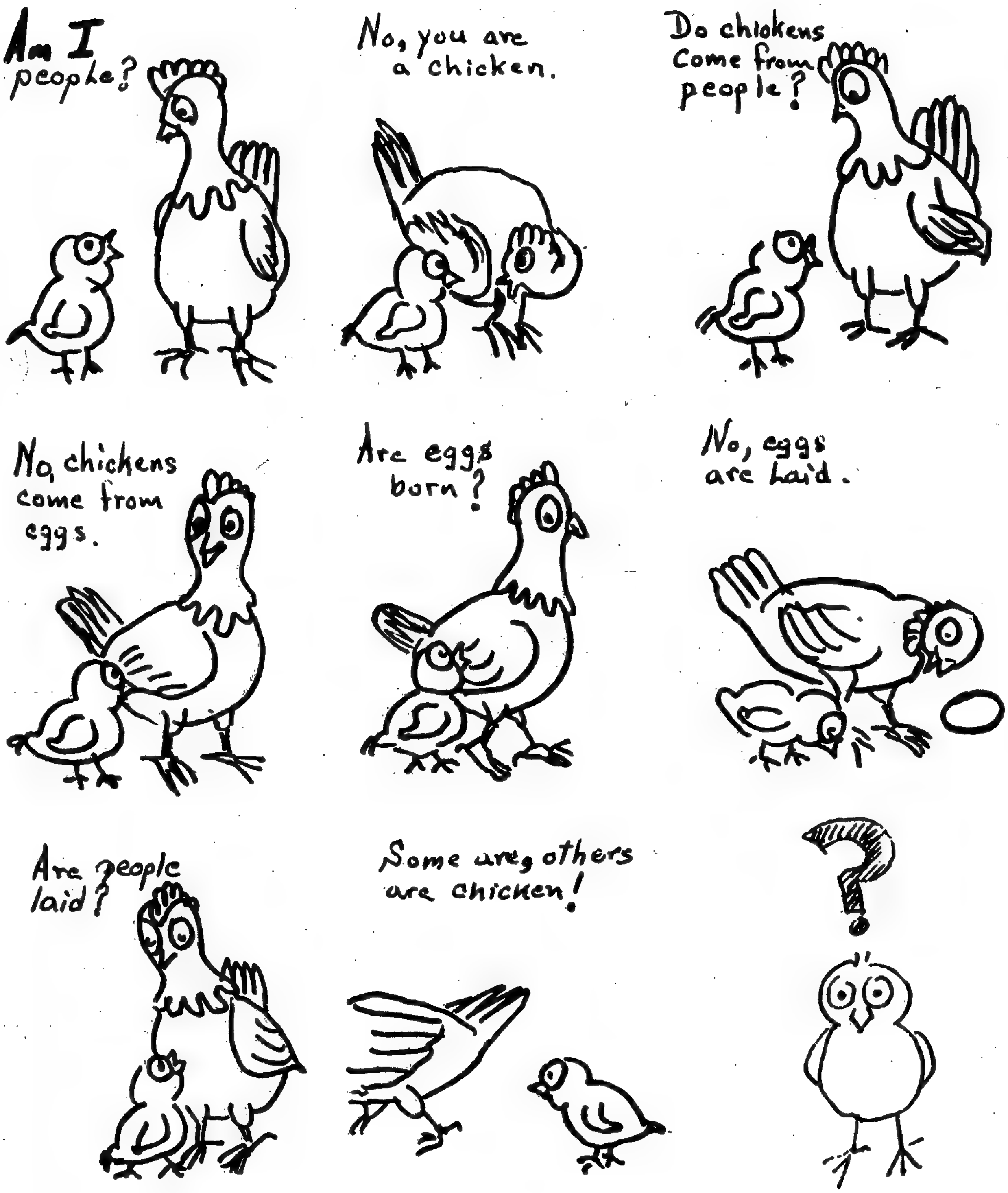
   the Committee recommends that

   Member States of the EEC participating to the work of the Bird Strike Committee Europe will send to the Committee a copy of their annual report to the Commission of the EEC.

2. Whereas the EEC directive on the conservation of wild birds (79/409/EEC) and especially article 9 § 4,

   the Committee decides

   to send a letter to the Commission of the EEC in order to be kept informed of the decisions the Commission may take, if and when incompability between the provisions of the directive and national measures taken in the interests of air safety is proved.


Am I people?
No, you are a chicken.
Do chickens come from people?
No, chickens come from eggs.
Are eggs born?
No, eggs are laid.
Are people laid?
Some are, others are chicken!
?

LIST OF PARTICIPANTS.

LIST OF PARTICIPANTS

Name	Organization - Address
Austria	
O. Lhotsky	Department of Civil Aviation Elisabethstrasse 9 A-1010 Vienne
Belgium	
J.F. Boomans	Meteo Wing Luchtmacht Lange Eikstraat 86 B-1970 Wezembeek
L.G. Delanghe	Regie des Voies Aériennes Direction Exploitation Avenue des Arts 41 B-1000 Bruxelles
W. Depouillon	SATCO Belga Radar Ten Edestraat 21 B-9745 Semmerzake TP/EBSZZP
M. Haerynck	Ministerie van Verkeerswezen Bestuur der Luchtvaart WTC Toren 1, P.O.Box 60 E. Jacqmainlaan 162 B-1000 Bruxelles
Theofil Jacobs	Commandant M.C. Provinciebaan 4 B-9744 Gavere
F. van Remoortel	Air Force Staff (VDS) Kwartier Elisabeth Eversestraat B-1140 Bruxelles
Canada	
H. Blokpoel	Canadian Wildlife Service Ontario Region 1725 Woodward Dr. Ottawa, Ontario K1G 3Z7 Canada

A.J. Laflamme	National Defence Headquarters Ottawa, Ontario K1A OK2 Canada VCDS/DFS 2-2-5
C. Lockhard	1 Canadian Air Group Headquarters CFPO 5000 D-7630 Lahr
R.B. Rathbone	1 Canadian Air Group Headquarters CFPO 5000 D-7630 Lahr
V.E.F. Solman	Canadian Wildlife Service Department of Environment Ottawa K1A OE7 Canada
Kenneth K. Wilde	International Civil Aviation Organization - ICAO 1000, Sherbrooke Street West Montreal, P.Q. H3A 2R2 Canada
L.G. Wilson	Aeronautical Services 5th Floor C-55 Building P.O.Box 9000 Montreal International Department Dorval, Quebec H4Y 1C2 Canada

Czechoslovakia

J. Solc	Uster Krajënne ekologie, ESAV Bezručova 927 RICANY u Praky

Denmark

Hans P. Dahl	Luftfartdirektoratet Codanhus, Gl. Kongevej 60 DK-1850 København V.
A.M. Glennung	Copenhagen Airport Authority 2770 Kastrup
Bent Junker Hansen	Game Biology Station Kalo, 8410 Rönde
J.H. Lauritsen	Royal Danish Air Force Tactical Air Command Denmark Tacden DK-7470 Karup J

E.P. Schneider — Air Station Vaerlöse
P.O.Box 124
Vaerlöse

Federal Republic of Germany

J. Becker — German Military Geophysical Office
W II 4
Mont Royal
D-5560 Traben-Trarbach

D. Brüssow — Directorate Flying Safety
Federal Armed Forces Germany
P.O.Box 902500/501/07
D-5000 Köln 90

Hans J. Eberhardt — Hochschule für Technik Bremen
Pösneckerstrasse 7
D-2800 Bremen 41

Jochen Hild — German Air Force
Mont Royal
D-5580 Traben-Trarbach

Werner Keil — Ausschuss zur Verhütung von
Vogelschäden im Luftverkehr
Steinauer Strasse 44
D-6000 Frankfurt/Main 61

W.O. Politt — Federal Administration of
Civil Aviation
Luftfahrt - Bundesamt
P.O.Box 3740
D-3300 Braunschweig

M. Reif — BWB-ML
Landshuter Allee 162 a
D-8000 München 19

W.E. Wester — MBB-UH
Abteilung HE 411
D-2101 Hamburg 95

Finland

O. Stenmann — Finnish Game and Fisheries Research
Institute
Game Division
Unioninkatu 45b
F-00170 Helsinki 17

Olli Uusitalo	National Board of Aviation Airports Department P.O.Box 50 SF-01531 Helsinki-Vantaa-Lento

France

Jean-Claude Albert	Direction Général de l'Aviation Civile SFACT/TU 36, Rue du Louvre F-75001 Paris
R.J. Arizzi	SNECMA Dept. YLCF Centre d'Essais de Villaroche F-77550 Moissy-Cramayel
A. Attig	Inspection Général de l'Aviation Civile 246, Rue Lecourbe F-75732 Paris Cédex 15
J. Barrere	Centre d'Essais des Saclay Rofulseurs 117, Boulevard de Palaiseau F-91120 Palaiseau
Jean Besse	Avions Dasseult 121, Rue F. de Sourdis F-33000 Bordeaux
G.H. Capsey	European Civil Aviation Conference 3 bis, Villa-Emile-Bergerat F-92200 Neuilly-sur-Seine
Elisabeth Dallo	Direction Général de l'Aviation Civile - Service Economique et International 39, Boulevard du Montparnasse F-75006 Paris
J. Delol	Service Technique de la Navigation Aérienne 246, Rue Lecourbe F-75015 Paris
Vital E. Ferry	Direction Général de l'Aviation Civile 93, Boulevard du Montparnasse F-75006 Paris
F. Gautier	Inspection Général de l'Aviation Civile 246, Rue Lecourbe F-75732 Paris Cédex 15

Marc Laty	Centre Régional de la Navigation Aérienne Avenue J. Isaac F-13100 Aix en Provence
Georges Marcal	Compagnie Nationale Air France Département Lignes et Régions F-94396 Orly Aérogare Cédex
Christiane Neveux	Service Technique Aéronautique 4, Avenue de la Porte d'Issy F-75013 Paris
Jean-Claude Sonnette	SNPL-COMETEC Orly SVD 40 213 F-94396 Orly Aérogare Cédex

Hungary

Stephen Zerkovitz	Air Traffic and Airport Administration Airport Ferihegy Budapest 180

Israël

S. Suaretz	The Nature Reserves Authority Hanatzin Str. 16 Tel Aviv

Italia

Lucci	WEAA Soc. Aeroporti di Roma Fumicino-Roma

The Netherlands

C. Bakker	KLM AMS/OL Amsterdamsestraatweg 55 1182 GP Amstelveen
J. Biemond	Schiphol Airport Authority P.O.Box 7501 1118 ZG Schiphol Centrum
L.H. Bos	Schiphol Airport Authority P.O.Box 7501 1118 ZG Schiphol Centrum
H.P. Bouhuys	Rotterdam International Airport P.O. Box 12025 3004 GA Rotterdam

T.G. Brom	Nyl 147 1186 JG Amstelveen
L.S. Buurma	Koninklijke Luchtmacht Afd. Luchtmachtbedrijfsveiligheid Prins Clauslaan 8 2595 AJ Den Haag
A.H. van Geuns	Schiphol Airport Authority P.O.Box 7501 1118 ZG Schiphol Centrum
A. Klaver	Schiphol Airport Authority P.O.Box 7501 1118 ZG Schiphol Centrum
Ferdinand Kuijk	Laan van Vollenhove 182 3706 AA Zeist
H. Lambermont	Department of Defence C.T.B. Van Soutelandelaan 18-40 2597 EZ Den Haag
P.H.C. Lina	Ministry of Cultural Affairs, Recreation and Social Work Steenvoordelaan 370 2284 EH Rijswijk
A.M. Peeraer	Ministry of Agriculture & Fisheries Direction Faunabeheer Postbus 346 2700 AH Zoetermeer
G.J. Plukkel	IFALPA Vliegveiligheid V.N.V. Zuiderhout 2 1695 AR Blokker
I. Tengeler	Laboratory for Electric Development of Armed Forces/TNO Haarlemmerstraatweg 7 2343 LA Oegstgeest
F.J. Verheijen	Laboratory of Comparative Physiology State University Utrecht
H.J.D. van Wessum	Department of Civil Aviation Plesmanweg 1-6 2597 JG Den Haag

Norway

J. Michaelsen	Zoological Museum Sarsgate 1 N-Oslo 5

Portugal

José Pimentel Santos	Direcçâo de Navegaçâo Aera Arruamento B - Edificio 6 Aeroporto Lisboa

Sweden

S.H. Andersson	Aprilvägen 52 S-175 40 Järgfälla
J. Karlsson	University of Lund Ecology Building Helgonavägen 5 S-223 62 Lund
B. Larsson	Met Office Krigsflygskolan S-260 70 Ljungbyhed
Milton Mobärg	SAAB-SCANIA Aero Space Division Fack S-581 88 Linköping
Karin I.M. Mossler	Drakenbergsg. 31 S-117 41 Stockholm
Bertil von Schantz	Board of Civil Aviation Fack S-601 01 Norrköping
Lars-Olof Turesson	Board of Civil Aviation Fack S-601 01 Norrköping
A. Ulfstrand	University of Lund Ecology Building Helgonavägen 5 S-223 62 Lund

Switzerland

Bruno Bruderer	Schweiz. Vogelwarte CH-6204 Sempach

Max Lüthi	Bundesamt für Militärflugplätze Swiss Air Force CH-8600 Dübendorf
K. Nilsson	IATA P.O.Box 160 CH-1260 Cointrin-Geneva
Ulrich Schneiter	Federal Office for Civil Aviation CH-3003 Bern

Turkey

Aktürk Ziya	Turkey Civil Aviation Authority Ulaş Bakanliği Md. Lügü Istasyon Ankara
E. Tunali	Ministry of Communications Direction of Planning and Coordination Ankara - Gar

United Kingdom

T. Brough	MAFF Agricultural Science Service Worplesdon Laboratory Tangley Place Worplesdon - Guildford Surrey GV3 3LQ
E.P. Church	Department of Trade Accidents Investigation Branch Kingsgate House 66-74 Victoria Street GB-London SWIE 69T
K.D. Crisp	Directorate of Aerodrome Standards CAA, Room 120 129 Kingsway London
R. Kingston	Ministry of Defence Adastral House Theobalds Road London WC 1
A.D. Lloyd	Rolls Royce Aero Engines 20, Fowler Avenue Spondon, Derbys

Peter F. Richards	Civil Aviation Authority Airworthiness Division Brabazon House RH6 9JH Redhill, Surrey
John Thorpe	Civil Aviation Authority Safety Data Unit Brabazon House RH6 9JH Redhill, Surrey
M.S. Wooding	British Aerospace Warton Aerodrome Division Warton

USA

Sidney A. Gauthreaux Jr.	Department of Zoology Clemson University Clemson, South Carolina 29631
M. Harrison	Office of Airport Standards AA5-300 Federal Aviation Administration 800, Independance Avenue S.W. Washington D.C. 20591
J.L. Seubert	Denver Wildlife Research Center Building 16 Federal Center Denver, Colorado 80225
J. Short	AFESC/Devn Tyndall AFB, Florida 32403
R. Speelman	Air Force Flight Dynamics Laboratory AFFDL-FEA Wright Patterson Afb. Ohio
F.N. Swink	U.S. Fish & Wildlife Service Washington D.C. 202400

USSR

A. Dwornikow	Air Force Expert Flight Safety Moscow
B. Groubi	Ministry of Civil Aviation Leningradsky AV 37 Moscow
O. Trunov	USSR Civil Aviation Aeroflot National Research Institute Moscow
S. Ugarkin	Ministry of Civil Aviation Leningradsky AV 37 Moscow
A.P. Kanin	